

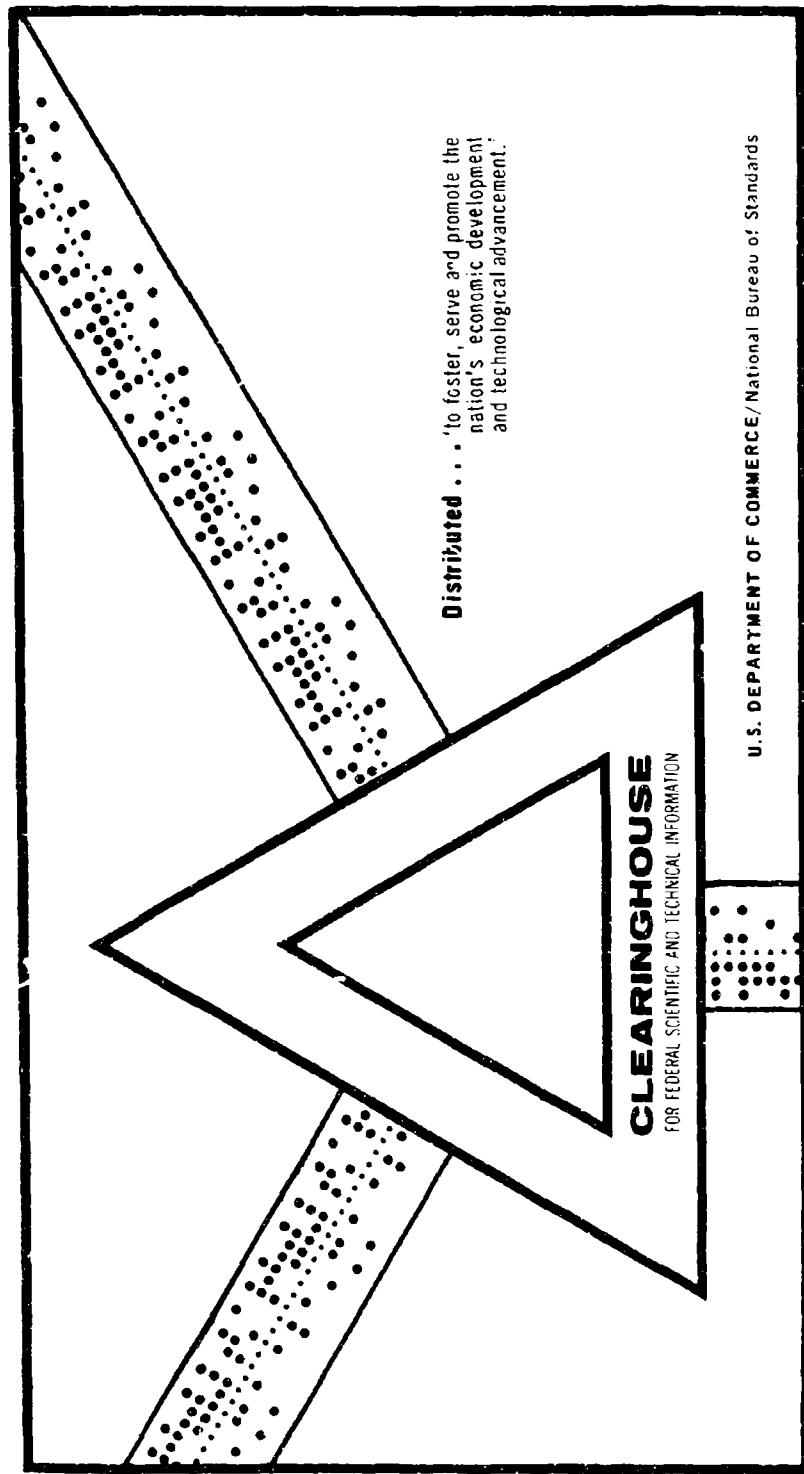
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STUDY OF RECRUDESCENT TYPHUS IN ISRAEL

Marcus A. Klingberg, et al

Israel Institute for Biological Research
Ness-Ziona, Israel

March 1969



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FINAL TECHNICAL REPORT

By

Marcus A. Klingberg, M. D.
Robert A. Goldwasser, Ph. D.
Wanda Klingberg, Ph. D.

March 1969

EUROPEAN RESEARCH OFFICE
United States Army

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ISRAEL INSTITUTE FOR BIOLOGICAL RESEARCH
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SUMMARY

The study was undertaken in order to determine whether persons, once infected with epidemic typhus could subsequently suffer relapses, without clinical signs which could be detected by rises in antibody titer. Such cases of recrudescent typhus could presumably serve as sources of the microorganism in the interepidemic period and therefore be responsible for the initiation of new epidemics.

The study was conducted among individuals most of whom had contracted epidemic typhus in Eastern Europe and immigrated to Israel after the Second World War. In enlisting volunteers for the study particular attention was paid to the reliability of their histories and the absence of murine typhus in their present environment. 294 individuals were thus selected.

Interviews and sampling of bloods were conducted at regular two-three months' intervals. Six blood samples were obtained from 262 individuals and at least three samples from the rest.

All sera obtained from any individual were examined in the same test for specific antibodies to epidemic typhus by complement-fixation and microagglutination.

To facilitate interpretation the serological results were arbitrarily divided into three groups:

Group A - 34 persons (11.6%) who failed to exhibit demonstrable CF antibodies ($\leq 1:10$) or significant MA titers ($\leq 1:8$);

Group B - 196 subjects (67.1%) with a CF titer $\geq 1:10$ and/or MA titer ≥ 8 .

Group C - 62 seropositive volunteers (21.2%) showing at least four-fold fluctuations in titer by at least one serological method.

These volunteers were considered as possible cases of "sero-relapse".

BACKGROUND

The accumulated results of studies over the past four decades show that primary epidemic typhus and Brill-Zinsser disease represent classic examples of primary infection and relapse caused by a single etiologic agent.

Epidemic typhus occurs as a severe primary disease with epidemic spread from man to man by means of the human body louse. Brill-Zinsser disease, on the other hand, is a relatively mild disease that occurs sporadically, in the absence of lice, and is explained as a relapse of recrudescence of epidemic typhus in individuals who previously suffered an attack of the classic disease (1, 2).

Epidemic louse-borne typhus fever (Typhus Exanthematicus, Classical Typhus Fever) has been endemic in Europe and Asia for centuries. During and immediately after the First World War and also during the Second World War there were widespread epidemics of typhus in Eastern Europe and, between the wars, smaller epidemics occurred. The mechanism by which the disease maintained itself between epidemics is not clear.

Between 1896 and 1910 Nathan Brill, a physician in New York City, observed the occurrence of a sporadic typhoid-like disease in which the Widal reaction was invariably negative. These cases had several characteristics in common: the illness seemed to appear chiefly among Jewish immigrants from Russia and Poland; two cases never occurred in the same family; headache and fever of 7 to 11 days duration were the most prominent symptoms; and the most characteristic feature of the disease was a maculopapular rash beginning on the fifth or sixth day in the majority of the cases.

The term "Brill's disease" was for many years also applied to the sporadic cases of "endemic" typhus in the southern United States, until Mooser in 1928, while working in Mexico City, first recognized the different biological characteristics of the rickettsiae causing the disease which he named murine typhus, and which was shown to be transmitted by rat fleas to man.

In 1934 Zinsser (1) advanced the hypothesis that Brill's disease represented a recrudescence of latent, louse-borne typhus fever. Zinsser's hypothesis was based on the isolation of strains of Rickettsiae prowazekii from three patients suffering from Brill's disease, and on an epidemiologic analysis of 414 reported cases of Brill's disease which showed that in all cases this disease developed

in patients coming from typhus-epidemic areas. Zinsser's studies made it clear that latent infection with R. prowazekii can persist for many years after primary infection, although the highest number of activations occur during the first ten years after the initial infection. Zinsser postulated the persistence of the typhus rickettsiae during the latent interval somewhere in the tissues of the human subject.

In 1934 Plotz (3), using the complement-fixation test with specific antigens, was able to prove beyond any doubt that the New York cases of Brill's disease give the same reaction as those obtained in cases of Old World louse-borne typhus.

Zinsser's hypothesis that man can serve as an interepidemic reservoir for R. prowazekii, and the possible epidemiologic importance of the recrudescences have been verified, mainly in recent studies. The hypothesis was confirmed in 1950 by Murray and his associates (2, 4) who isolated 7 strains of R. prowazekii from 14 patients with Brill-Zinsser's disease, by feeding human body lice on the patients. This was an important observation since it was shown that man could harbor latent R. prowazekii and that these microorganisms might become activated and infect lice. Some years later - in 1955 - Price and his coworkers (5, 6) succeeded in isolating R. prowazekii from the lymph nodes of two apparently healthy individuals - immigrants from Russia - after they had been residing in the United States for more than 25 years. Both of them had low titers (1:10) of complement fixing (CF) and neutralizing (NT) antibodies to R. prowazekii, indicating previous typhus infection. Neither of the two subjects had clinical signs or symptoms suggestive of active infection. Price also isolated epidemic typhus rickettsiae from a patient with recrudescent typhus fever (6).

The factors which precipitate Brill-Zinsser disease are not known; consequently, there are no data on the incubation period. Likewise the importance of Brill-Zinsser's disease as a source of new epidemics of typhus fever is not known, since it is not clear how frequently recrudescences occur. It has generally been assumed that they are rare.

Murray and his collaborators (7) have shown in a group of immigrants from epidemic areas - some of them residing in the United States for over 40 years - that a high proportion of them - 20 out of 50 have residual complement-fixing and neutralizing antibodies to R. prowazekii. Also Price and his colleagues (5), during a five-year study on 1,708 immigrants from Eastern and Southeastern Europe, primarily from

Russia, found that approximately 30 percent of them had CF antibodies to R. prowazekii. During this study they followed up 308 persons who had positive CF antibodies with epidemic typhus antigen. These individuals had been bled at least 3 times a year for a period of 3 years. No evidence of recrudescence as indicated by a significant rise in CF antibody titer was observed in the persons under study. Their CF titers remained remarkably constant and no evidence for Brill-Zinsser disease was found in any of these patients, in spite of the fact that in a few of them both complement-fixing and neutralizing antibodies disappeared at some point during the 3-year period and remained undetectable for at least one year.

In marked contrast to the above findings of Price et al., Zivkovic et al. (8) in Yugoslavia reported that serologic recrudescences without clinical symptoms, which they called "sero-relapses", were fairly common. The Yugoslavian study was performed in an endemic area of louse-borne typhus. They investigated 50 persons with a history of proven epidemic typhus which occurred in 1951-56, and performed CF tests with epidemic typhus antigen on sera collected from them at frequent intervals during 1956-59. They stated that six of them showed major changes in titer (fluctuations) indicative of serologic recrudescence. Their results indicate that recrudescences might occur at the rate of five to ten percent per year, and that healthy individuals, known to have had typhus in the past, may probably be the main interepidemic reservoir of R. prowazekii.

It is worthwhile mentioning that in a survey performed by Zivkovic et al. (8) in 1958-59 on 9,426 sera (received for Widal or Wasserman tests), five to six percent had a positive CF titer (of 1:8 or higher) with epidemic typhus antigen.

Purposes of the present study

The present study was undertaken at the end of 1964 with the aim to investigate infectious potential among persons recovered from epidemic typhus. The purpose of the study was to determine if there is an occurrence of "sero-relapses" in persons who recovered from classical exanthematic typhus, and what is the rate of serologic recrudescence among them.

Israel was chosen for conducting this study because of the following advantages. Tens of thousands of immigrants, victims of louse-borne

epidemic typhus, came to Israel after the Second World War. They suffered a primary attack of classical typhus in their former residence, either in Eastern Europe during their stay as inmates of the notorious Nazi Concentration Camps and Ghettos or had lived in the Soviet Union during World War II. These immigrants have since lived in Israel - an environment completely free of epidemic typhus, where human body-louse infestations are rigidly controlled.

MATERIALS AND METHODS

The study group

While planning this study, we assumed that the enlisting of persons who were infected with epidemic typhus fever before their immigration to Israel would be a simple matter. Since approximately 70 percent of the population of this country and over 90 percent of the newcomers are members of the Sick Fund we thought that it would be easy to trace such persons through their Sick Fund admission cards. However, in almost none of the admission cards were such anamnestic data included. Therefore, we had to contact hospitals, out-patient clinics, and private physicians as well as aged persons' homes with the aim to obtain from them names of persons with a past history of typhus. Here, too, great difficulties were encountered in enrolling such subjects; for example, some aged persons did not remember or were unable to reconstitute the anamnesis and thus we could not include them in the study. We succeeded only partly in our task and the number of individuals from these sources was very small.

The enrolling of a large number of persons was made possible through the cooperation extended by the Organization of Former Inmates of the Nazi Concentration Camps in Tel-Aviv whose members were ready to participate in this research program. Further volunteers were enrolled from the communal settlements (Kibutzim): Nizanim and Kfar Hahoresh and from the Sick Fund Polyclinic of Ness-Ziona, where many former immigrants from Eastern Europe are registered. Similarly, as a result of the cooperation given by a medical supervisor of some industrial enterprises, we were able to trace and enroll many persons who had a history of louse-borne typhus infection. The slow process of enlisting volunteers caused the research to begin later and thus considerably prolonged the time required for this project.

It was first planned to enroll 200 - 400 volunteers. In fact we succeeded in enrolling 440 persons for the purpose of this study. Of the original number of 440 participants, 163 withdrew their cooperation: 107 - after the first bleeding, 39 - after the second bleeding and 17 - after the third bleeding. Another person (case number 206), from whom three blood samples were obtained, died shortly thereafter from causes unrelated to this study.

All of the individuals enrolled were visited, interviewed, their typhus histories obtained and special questionnaires filled out. In the enrollment, consideration was given to the reliability of history (some volunteers gave descriptions that fit the clinical picture of epidemic typhus; and some knew for sure that they had typhus), willingness to volunteer, and to the absence of murine typhus in the home and work environment.

The first interview and the subsequent recruiting of the person was followed by regular interviews at approximately two - three months' intervals, at which time health histories were taken. At each interview a blood sample was obtained.

A public health nurse and a social worker were engaged for home visits, checks with physicians and for bleeding the volunteers.

Collection and handling of blood specimens

Blood specimens were collected aseptically from the vein; as soon as the blood clot formed the specimens were placed on ice and transferred to the laboratory on the same day. The serum was separated by two centrifugations in a refrigerated centrifuge and stored immediately in a freezer at -20°C (-4°). All sera collected from the same individual were tested simultaneously, so that the same test system would be employed for the whole series of bleedings.

Serological tests

According to the contract, we were supposed to carry out CF tests on all bloods. These tests were, indeed, done. Since, however, a high proportion of sera were anticomplementary, it was decided upon the advice of Dr. Wisseman, to test all bloods by the microagglutination method as well, which does not depend upon complement. Also in Dr.

Wisseman's laboratory all bloods were tested by both methods at the same time.

Complement - fixations test. - A standard micro complement-fixation (CF) test technique was used according to the LBCF method (Lab Branch CF) (9) modified by Dr. Charles C. Shepard of the National Communicable Disease Center, Public Health Service, Atlanta, Ga.

The titration of hemolysin, complement and antigen was performed in the standard volume of 1.0 ml and measured spectrophotometrically. The hemolysin was determined by the plateau method. Complement was determined as 50% unit, and five 50% units were used in the test.

The antigen in a lyophilized form was obtained from Dr. Charles L. Wisseman, Head and Professor, Department of Microbiology, University of Maryland School of Medicine, Baltimore, Md. ; it is of a soluble variety prepared from R. prowazeki. Prior to lyophilization, it was dialyzed against water to remove formalin and salts. It was reconstituted in our laboratory with saline containing 0.1% formalin, and allowed to stand at 4°C overnight before use.

The reference serum (V-10800) was human typhus immune serum, also supplied by Dr. Wisseman in lyophilized form. The serum was reconstituted with distilled water, containing 1:10000 merthiolate.

The micro LBCF test was performed using the Micro-titer system. Sera were diluted 1:10 and inactivated for 30 min. at 56°C. Two-fold dilutions were prepared in lucite plates with 0.025 ml loops from 1:10 through 1:80 and 0.025 ml containing 2 units of antigen were added to each dilution. For each serum dilution in the test, a serum-C' control was added. Controls of antigen and complement with 5C'H₅₀, 2.5C'H₅₀ and 1.25C'H₅₀, reference serum and RBC were included. After overnight incubation in the refrigerator (4°C), 0.025 sensitized red blood cells were added and placed in a 37°C incubator. After 30 min. the plates were removed, centrifuged and read by comparison with a 30% color standard.

Microagglutination test. - The antigen used in these tests was supplied by Dr. Charles L. Wisseman in the form of a suspension of R. prowazeki, standardized at 1.0 mg/ml dry weight. For use in the microagglutination (MA) test the suspension was diluted 1:2.5 in physiological saline containing normal human serum.

Sera to be used in the tests were heat-inactivated at 56° C for 1/2 hr. Dilutions were carried out from 1:2 - 1:512 in the microtiter system in volumes of 0.025 ml.. The diluent used was as for the antigen, i. e. 0.15 M NaCl containing 0.5% normal human serum.

On completing the serum dilutions, one drop of 0.025 ml antigen was added to each dilution, the plate contents mixed and placed in the refrigerator at 4° C overnight. Known positive and negative control sera were included in each test. In addition, appropriate serum-saline controls were also included.

The plates were read on the following morning with the aid of a magnifying mirror. The presence of a "button" of antigen in the bottom of a well in the microtiter plate was taken as indication of no agglutinin, whereas a film covering the bottom of the cup is a positive reaction. There are also intermediate patterns of partial agglutination. The highest serum dilution showing partial agglutination is taken as the endpoint.

According to the program, sera obtained from the volunteers were divided into equal lots: one for testing in our Institute, another for testing Dr. Wisserman's laboratory. The sera which had accumulated for Wisserman's laboratory were sent by air on dry ice to Baltimore, Md. This arrangement was made so as to enable us to compare the serological results obtained in the two laboratories.

RESULTS

Out of the total number of 440 volunteers participating in this study, 294 volunteers were bled three times or more, as is shown below:

Number of bleedings	Total	Six	Five	Four	Three
Number of volunteers	294	262	6	8	18

As stated before an additional 107 persons withdrew their co-operation after the first bleeding and 39 after the second one, and were excluded from the study.

Each of the volunteers gave a history suggestive of a previous attack of typhus which occurred while they resided in areas which had been swept over by louse-borne typhus. The volunteers described in detail the clinical symptoms and signs consonant with a diagnosis of epidemic typhus. Almost all of them recalled the exact year of the illness and gave a history of an outbreak, or an epidemic of typhus, in their vicinity.

Detailed information regarding these individuals such as age, sex, year of onset of primary epidemic typhus, place where the disease was contracted with specification if this occurred in Concentration Camps, Ghettos, Forced Labor Camps, etc. as well as the month and year of the consecutive bleedings is given in Appendix A. All the volunteers listed in Appendix A were bled at two to three months' intervals over a two-year period, as from the middle of 1965; no more than six blood samples were taken from any one individual.

Epidemiologic Data

As recorded in Table 1 it can be seen that the great majority of the subjects under study (263 out of 294 volunteers - 89%) were persons who, according to their declarations, contracted epidemic typhus in the Second World War, during widespread epidemics of typhus in the areas from which they came. They can be divided by place of illness as follows:- Nazi Concentration Camps - 116 individuals (44%), Ghettos - 74 (28%), Forced Labor Camps - 27 (10%), Russia - 23 (8.7%). The remaining twenty-three persons were ill in Roumania (5), North Africa (5), etc. Additional twenty-nine volunteers suffered from typhus before or during the First World War (9 persons), between the two wars (16) or after the Second World War (4). It should be borne in mind that also during the First World War and between wars there were epidemics of exanthematic typhus in Eastern Europe.

The country of origin of the volunteers is not indicated in the Table, because in most cases the country of origin and the place where infection was actually contracted overlap. This is especially

true as regards those coming from Poland and Russia, but persons who came from Greece suffered from epidemic typhus when they were transferred to Poland (concentration camps, ghettos). The same happened to Jews from Roumania and Hungary who were transported to other countries, e.g. Poland.

Almost all of the volunteers were over 30 years of age; the majority being in the 41-60 age group, representing 65% of all persons under study, with a mean age of 50 years. Divided by sex, there were 165 males and 129 females (M/F ratio 1.3). Table 2 shows the age distribution of the male and female volunteers.

While the volunteers came from endemic areas of epidemic typhus fever, there is no louse-borne typhus in their new environment. Israel is free of epidemic typhus infection and no body lice infestation is known to exist.

Serologic Data

In the first stage of the study all the sera collected were tested by the complement fixation technique. To ascertain the validity of the results, all bleedings from any individual were examined simultaneously in a single CF test. In addition, many of the tests were repeated several times, especially when fluctuations in titer were observed or when anticomplementary (AC) reactions were encountered. It should be pointed out that a high proportion of sera showed anticomplementary activity and this constituted a major technical problem in the evaluation of the results. This phenomenon appeared in 789 out of 1671 specimens collected and tested as is evident from Appendix B. The AC activity compelled us to remove a significant number of specimens from the CF test series. In order to avoid the elimination of these sera, another serological test - microagglutination which is independent of complement was added to the study. Therefore microagglutination tests were carried out on almost all the above serial bleedings. The serological results were analyzed separately for each test, because the results obtained by the two methods (CF and MA) were not in full agreement. The details of all the CF and MA tests are tabulated in Appendix B.

Complement Fixation. - The overall results show that the titers varied between <10 and 80. From the total number of volunteers tested by the CF method, twenty-seven individuals (9.2%) were excluded,

since all of their sera turned out to be anticomplementary for unknown reasons. Attempts were made to reduce or eliminate the AC activity by various methods such as: higher inactivating temperature, separating the globulins through absorption to various resins, etc., without success in a significant number of sera.

To facilitate an interpretation of the results, we divided all the remaining individuals into three major groups, as follows:-

Group A (CF negative) - persons whose sera throughout the five or six bleedings presented titers of ≤ 10 . The number of volunteers included in this group was seventy-three representing 27.4 percent of the 266 individuals under study.

Persons included in the following two groups (B, C) are considered to be positive reactors.

Group B (CF positive) - includes one hundred sixty-two persons (61%) whose sera showed a CF titer of 1:10 or higher in at least one of the bleedings but did not show significant fluctuations in titer.

Group C (at least four fold fluctuations in CF titer) - thirty-one individuals (11.6%) are included in this group. Details of these CF tests are presented in Table 3. Some of them showed an eight fold-rise or fall in titer; others presented four fold fluctuations. The variations in titer occurred either in successive or in non-successive bleedings.

Table 4 shows the grouping of the volunteers according to the CF results.

Microagglutination test. - By this method the sera of 286 volunteers were examined. The agglutinin titer of the sera checked between ≤ 2 and ≥ 256 . The individuals were distributed in three groups (Table 5), in a way similar to that done with the CF results.

Group A (MA negative) - 40 volunteers (14%) whose sera constantly showed a titer of ≤ 8 .

Group B (MA positive) - 208 individuals (72.7%) in whom at least one serum showed an MA titer of ≥ 8 , but did not show significant fluctuations in titer.

Group C - 38 persons (13.3%) who demonstrated at least four fold fluctuations in MA titer. Table 6 presents the details concerning this group. It may be seen that the majority of cases (25) showed four fold fluctuations; eight persons exhibited eight fold changes; two cases showed sixteen fold changes and three individuals presented thirty-two fold fluctuations in MA titer.

Summary of Serologic Findings. - It was assumed that complement fixation titers of at least 1:10 and/or microagglutination titers of at least 1:8 indicate the presence of specific antibodies to epidemic typhus rickettsiac. Individuals who had complement fixation titers of less than 1:10 and/or microagglutination titers of not over 1:4 were considered for the purposes of this study as seronegative.

The serological results obtained by the two tests were divided into three groups: A, B and C as described above. Group A includes 34 (11.6%) out of 292 persons successfully tested by one or both methods. 258 of the volunteers (88.4%) who showed positive serological findings, are divided into Group B and C according to the above criteria. Group B includes 196 persons (67.1%) whose sera were considered by us as seropositive, but throughout the period of study there was no evidence of serological relapse among them. Of special interest are the 62 cases (21.2%) constituting Group C who exhibit four to eight fold variations in antibody titer in the CF test or in the MA test or in both tests (Table 3 and 6).

The sera of only 260 volunteers were successfully examined by both methods. This number does not include 27 individuals all of whose sera exhibited anticomplementary activity in the complement fixation test. The comparison of results obtained by both serologic methods is presented in Table 7. Out of the 260 individuals examined, 170 cases (65.4%) demonstrated similar results when tested by both methods. Of the 260 volunteers twenty-eight persons (10.8%) were found to be seronegative by both tests; one hundred thirty-five individuals (51.9%) fall into Group B; and seven volunteers (2.7%) exhibited at least four fold fluctuations in titer by the two serological methods.

DISCUSSION

From the epidemiologist's point of view, Brill-Zinsser disease is of great interest as a possible source of dissemination of louse-borne typhus when conditions in a community are such that permit the development of louse infestation. Patients with Brill-Zinsser disease may then be the foci from which an epidemic of typhus fever may spread to susceptible people in the population.

Zivkovic *et al.* (8) reported of the existence of a new separate entity- serologic recrudescences without clinical symptoms- which they called "sero-relapses". Since the conditions of the study were such that the possibility of reinfections could not be ruled out, the present investigation was undertaken in Israel where the environment, in contrast to Yugoslavia, was ideal for verifying Zivkovic's hypothesis that "sero-relapses" may be a recrudescence of classical typhus, which might be of epidemiologic importance.

This report presents data on antibodies to epidemic typhus found in sera obtained from 294 persons who volunteered for this study. The volunteers, now residents of Israel, stated emphatically that they had had epidemic typhus, and almost all of them could clearly recall an acute attack of typhus fever at some time in the past.

An important problem was that of reconciling the serological evidence in the population studied with the history given by the volunteers.

It is well known that epidemic typhus antibodies may be demonstrated in many cases for long periods after the primary disease. However the duration and the magnitude of antibody titers to epidemic typhus have not been adequately investigated.

The serial bleedings (five to six during a period of 12 to 18 months) collected from the volunteers were tested by the micro complement fixation test and by the microagglutination method as well. The fact that a high proportion of sera exhibited anticomplementary activity, led us (10) to a supplementary investigation by a computational method (see Appendix C).

It was shown in our study that a significant population of the volunteers (88.4%) were found to have residual typhus antibodies many years after the primary attack. Only about half of them had unequivocal

evidence of epidemic typhus antibodies by both serological tests. The failure to find closer correlation between the results of the two serological tests suggests that the CF and MA antibodies are separate entities. It was also shown that a high proportion of sera, which did not contain complement fixing antibodies detectable by the method employed, nonetheless did contain significant titer in the micro-agglutination test. It is possible, therefore, that some of the volunteers whose sera were negative when tested by the two methods, might have given positive results when examined by another serological technique such as neutralization or fluorescent antibody tests.

It is a matter of interpretation whether the sixty-two volunteers (21.2%) who exhibited fluctuations in antibody titer constitute evidence for what has been called "sero-relapses". It must be emphasized that none of them showed any clinical symptoms or signs during their participation in this study that might be indicative of Brill-Zinsser disease. Such evidence on "sero-relapses" has not been distinctly presented in the literature except for the work of Zivkovic *et al.* (8). In that study much higher fluctuations (in CF titers - often 32 fold and higher) were reported. However, the Yugoslavian study was carried out at a time closely following primary epidemic typhus infection and in an endemic area of exanthematic typhus, where human body lice in the population occurs.

In contrast, the majority of other retrospective studies, including our own, was carried out, two or more decades following actual infection and in conditions which made it extremely unlikely or, as in the case of Israel, impossible, that R. prowazekii could have been picked up from the environment. Thus, the results of our study are not strictly comparable with those of Zivkovic *et al.* (8).

It should be emphasized that the present investigation was limited to specimens collected during a period of about one year, twenty or more years after the actual illness. A period of one year may be too short for pinpointing sero-relapses of the magnitude observed in the Yugoslavian study. Frequent bleedings spread over a longer period of time, may be necessary in order to find such great differences in titer as obtained by Zivkovic *et al.* The possibility must also be considered that an interval of two decades or more from the time of illness, decreases the probability of reactions of such magnitude and that a 4 to 8-fold fluctuation in titer as observed in the thirty-four cases presented in Tables 3 and 6, may constitute evidence for a serological recrudescence. On the other hand, although 4-fold changes in antibody titer are usually considered as significant, this may not be a result of recrudescence.

ADDENDUM

As mentioned in Materials and Methods, serological tests were carried out simultaneously in Dr. Wisseman's and in our laboratory. The comparative results are presented separately in Appendix D.

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Table 1

Data on 294 Volunteers with a Past History of Epidemic Typhus by Period of Illness and Place of Infection

Period of Illness	Number of Volun- teers	Place where infection was contracted										
		N.C.C.*	Ghettos**	F.L.C.	USSR	Poland	Roum- ania	Hung- ary	Germ- any	Aust- ria	Bulg- aria	North Africa
Until 1918	9					6	3					
1919-1938	16				5	3	2					
1939-1945	263	116	74	27	23	1	5	2	2	1	5	4
1946-1955	4					2	1					1
Unknown	2											1
Total	294	116	74	27	30	10	11	2	2	1	1	5
											11	4

* = Nazi Concentration Camp

** = Forced Labor Camp

Table 2

Data on 294 Volunteers with a Past History
of Epidemic Typhus by Age and Sex

Age Group (years)	Number of Volunteers	S E X	
		Male	Female
Under 30	5	3	2
31 - 40	48	32	16
41 - 50	110	59	51
51 - 60	84	48	36
61 - 70	30	19	11
Over 71	16	4	12
Unknown	1	-	1
Total	294	165	129

Table 3

Complement-fixation (CF) Tests of Sera of Thirty-one Individuals
Showing Fluctuations in Epidemic Typhus Antibody Titer (Group C)

Case Number	CF titer of serial bleedings					
	I	II	III	IV	V	V'
14	40	20	20	20	20	10
21	10	20/20	20	20	80	80
39	10/10	20	20/10	20	80	10
58	40	40/20	20/10	20/10	<10	20
81	20/10	20/10	20	<10	<10	<10
84	20/10	40/20	40	20	10	20
202	<10	20	<10	<10	<10	<10
228	40/20	20/10	<10	<10	40	10/10
268	10	20/20	40/20	40/10	20	40
277	10/10	80	80/40	20/10	80/40	<10
285	40/20	40/20	80	40	40/20	<10
292	10/10	<10	20/10	40/20	40	<10
295	40/20	40/20	40/20	40/20	40	<10
301	40	40/20	20/10	10	20/10	20/10
305	20/10	20	20/10	<10	40	20/10
414	40/10	40/10	80/10	40	40	20
422	10	<10	40/20	40/10	40/20	40/20
445	40/10	40/10	40/10	40/10	10	20
452	40	20/10	20/10	10	20/10	10
453	40	20/10	40	40	10	20
454	40	40	40	20/10	10	20/10
474	40/20	40/20	20	<10	20	20
480	40	20	20/10	20	20	10
605	40	20/10	20	20/10	40/10	80/10
806	20	20	20/10	20/10	<10	20
839	20/10	40	20/10	20	10	10
847	40/20	40	20/10	20/10	10	<10
854	80	40/10	40	80	20	40
857	40	80	80	20	80	40
858	80	80	80	40	10	
859	40/20	20	10	10	40	20

Table 4

Grouping of Volunteers According to the Results of Serial CF Tests

Individuals under Study *	Total	Group A (CF negative)	Group B (CF positive)	Group C (at least four fold fluctuations in CF titer)
Number	266	73	162	31
Percent	100	27.4	61.0	11.6

* The table does not include persons of whom all sera exhibited anticomplementary activity.

Table 5

Grouping of Volunteers According to the Results of Serial MA Tests

Individuals under Study	Total	Group A (MA negative)	Group B (MA positive)	Group C (at least four fold fluctuations in MA titer)
Number	286	40	208	38
Percent	100	14.0	72.7	13.3

Table 6

Microagglutination (MA) Tests on Sera of Thirty-eight Individuals
Showing Fluctuations in Epidemic typhus Antibody Titer (Group C)

Case Number	MA titer of serial bleedings					
	I	II	III	IV	V	VI
11	16	32	32	32	<2	<2
42	2	<2	<2	64	16	8
57	512	256	128	128	128	64
99	32	64	64	32	2	32
202	16	16	2	<2	<2	32
207		32	32	16	16	4
211	2	2	2	2	4	8
212	16	8	4	4	16	8
220	8	8	8	32	16	
225	32	16		16	16	64
227	8	4	2	4	8	8
228	2	2	2	4	8	16
233	16	16	8	8	<2	<2
235		4	16	8	8	8
236	128	128		64	32	32
256	8		16	8	4	2
285	16	8	32	32	32	
296	4	8	8	16	8	
401	32	16	8	8	8-16	8
403	16	16	64	64	64	32
406	2	2	16	8	16	8
424	16	32	8			
430	2	2	8	8	8	8
454	16	64	32	16-32	16-32	16-32
461	4	8	16	16	32	32
462	4	16	8	4		
465	8	32	16			
470	64	64	32	128	128	128
474	16	16	16	4	8	16
476	16	64	64	32	32	32
490	16	16	64	64	64	64
503	64	64	2			
520	2	8	8	8	8	8
607	128	64	128	256	128	256
705	<2	8	4	16	8	4
847	256	256	64	64	32	64
850	128	64	32	32	32	
854	128	64	32	32	64	64

Table 7

Comparison of Results Obtained by Complement-fixation and Microagglutination Tests for Epidemic Typhus Antibodies

Microagglutination Complement fixation	Group A*	Group B**	Group C***	Total
Group A*	28	35	9	72
Group B**	6	135	18	159
Group C***	1	21	?	29
Total	35	191	34	260

* Seronegative

** Seropositive

*** Seropositive showing fluctuations in titer of at least four fold

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
4	76	M	1945	Shuterberg , Germany , NCC	11/65	12/65	2/66			
7	39	M	1943/4	Warsaw , Poland , G	11/65	1/66	3/66	6/66	7/66	10/66
10	45	F	1944	Shutthof , Germany , NCC	11/65	1/66	3/66	5/66	7/66	8/66
11	58	F	1942	Mogilev , Ukraine , G	11/65	1/66	3/66	5/66	7/66	8/66
12	54	F	1941	Bershat , Ukraine , NCC	11/65	1/66	5/66	6/66	9/66	10/66
13	56	F	1941	Gordiwa , Ukraine , NCC	11/65	1/66	4/66	6/66	7/66	9/66
14	41	M	1944	Vachingen , Germany , FLC	11/65	12/65	3/66	5/66	7/66	9/66
20	63	M	1945	Dachau , Germany , NCC	11/65	1/66	2/66	5/66	7/66	8/66
21	52	M	1941	Byala Rawksa , Poland , G	11/65	2/66	4/66	5/66	7/66	9/66
22	56	M	1942/3	Yeruga , Ukraine , NCC	11/65	1/66	3/66	5/66	7/66	10/66
23	37	F	1944	Bergen Belsen , Germany , NCC	11/65	1/66	3/66	5/66	7/66	9/66
25	57	F	1945	Corlitz , Germany , NCC	11/65	3/66	5/66	7/66	10/66	12/66
26	89	M	1942	U	11/65	1/66	3/66	6/66	11/66	
27	55	M	1942	Bolbdy , Ukraine , G	11/65	1/66	6/66	11/66		
28	47	F	1944	Chinov , Poland , FLC	11/65	1/66	3/66	5/66	7/66	8/66
30	59	M	1945	Wustegorsdorf , Poland , NCC	11/65	2/66	3/66	5/66	7/66	9/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
36	60	M	1941	Warsaw, Poland	, G	12/65	2/66	4/66	6/66	8/66
38	44	F	1941	Mogilev, Ukraine	, G	12/65	5/66	6/66	7/66	8/66
39	57	F	1945	Bergen Belsen, Germany	, NCC	12/65	2/66	3/66	5/66	7/66
40	52	F	1941	Theresienstadt, Czechoslovakia, NCC	12/65	2/66	4/66	6/66	8/66	12/66
42	40	F	1944	Bomlitz, Germany	, FLC	12/65	3/66	5/66	7/66	9/66
43	47	F	1945	Bergen Belsen, Germany	, NCC	12/65	2/66	4/66	6/66	8/66
44	59	F	1945	Theresienstadt, Czechoslovakia, NCC	12/65	2/66	3/66	5/66	6/66	11/66
45	65	M	1945	Theresienstadt, Czechoslovakia, NCC	12/65	2/66	5/66	6/66	8/66	10/66
46	46	M	1942	Skarzysko, Poland	, NCC	12/65	2/66	3/66	5/66	6/66
47	44	M	1945	Bergen Belsen, Germany	, NCC	12/65	2/66	5/66	6/66	8/66
49	42	F	1942	Mogilev, Ukraine	, G	12/65	2/66	4/66	6/66	8/66
50	45	F	1942	Mogilev, Ukraine	, G	12/65	2/66	4/66	6/66	8/66
51	38	F	1945	Boizenburg, Germany	, FLC	12/65	2/66	3/66	5/66	11/66
52	39	F	1943	Skarzysko, Poland	, NCC	12/65	2/66	4/66	5/66	7/66
53	42	F	1945	Lodz, Poland	, G	12/65	2/66	4/66	6/66	9/66
55	48	F	1943	Blizyn, Poland	, NCC	12/65	2/66	4/66	6/66	7/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
57	59	M	1942	U. S. S. R.	12/65	5/66	7/66	9/66	10/66	12/66
58	38	M	1943	Skarzysko, Poland	NCC	12/65	2/66	3/66	5/66	7/66
59	44	M	1945	Gunskirchen, Germany	NCC	12/65	2/66	5/66	7/66	9/66
60	46	M	1945	Prague, Czechoslovakia	G	12/65	2/66	4/66	6/66	9/66
61	79	M	1942	Kazakstan, U. S. S. R.		12/65	3/66	7/66		
64	46	F	1945	Chinov, Poland	FLC	12/65	3/66	5/66	7/66	9/66
66	54	M	1943	Doroshitz, Ukraine	FLC	12/65	2/66	4/66	6/66	7/66
67	46	F	1940/1	Radom, Poland	G	12/65	2/66	4/66	6/66	8/66
69	42	M	1944	Kowel, U. S. S. R.		12/65	3/66	5/66	6/66	8/66
70	45	F	1945	Chinov, Poland	FLC	1/65	2/66	4/66	6/66	7/66
71	60	F	1942	Sokolov, Poland	G	1/66	2/66	4/66	5/66	7/66
72	37	F	1945	Theresienstadt, Czechoslovakia	NCC	1/66	2/66	4/66	6/66	8/66
73	61	F	1945	Bergen Belsen, Germany	NCC	1/66	2/66	3/66	5/66	7/66
74	71	F	1945	Theresienstadt, Czechoslovakia	NCC	1/66	2/66	3/66	5/66	7/66
76	71	F	1940	Transnistria, Ukraine	G	1/66	2/66	4/66	6/66	7/66
77	62	M	1944	Leitmeritz, Germany	NCC	1/66	2/66	5/66	7/66	9/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL

LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
78	60	M	1945	Theresienstadt, Czechoslovakia, NCC	1/66	2/66	3/66	6/66	7/66	9/66
79	44	F	1941/2	Riovitch Lubelsk, Poland	G	1/66	2/66	4/66	6/66	9/66
81	72	F	1943	Skarzysko, Poland	NCC	1/66	2/66	3/66	5/66	7/66
82	43	M	1945	Buchenwald, Germany	NCC	1/66	2/66	3/66	5/66	7/66
83	51	M	1941/2	Maldeni-Vlascia, Roumania	FLC	1/66	2/66	5/66	6/66	8/66
84	45	F	1943	Shianky, Poland	NCC	1/66	2/66	3/66	5/66	7/66
85	37	M	1941	Kroitze, Germany	FLC	1/66	3/66	4/66	6/66	8/66
86	43	F	1944	Blizyn, Poland	NCC	1/66	3/66	5/66	6/66	11/66
87	59	M	1945	Buchenwald, Germany	NCC	1/66	3/66	5/66	6/66	9/66
88	38	F	1943	Birkenau, Poland	NCC	1/66	2/66	5/66	6/66	10/66
89	45	M	1943	Warsaw, Poland	G	1/66	2/66	4/66	6/66	9/66
90	41	F	1941/2	Bershat, Ukraine	NCC	1/66	4/66	6/66	7/66	9/66
92	43	F	1944	Pross, Poland	NCC	1/66	2/66	3/66	5/66	7/66
93	40	M	1944	Noiengame, Germany	NCC	1/66	2/66	3/66	5/66	7/66
94	41	F	1945	Budapest, Hungary	NCC	1/66	3/66	5/66	7/66	8/66
95	43	F	1945	Bergen Belsen, Germany	NCC	1/66	2/66	3/66	5/66	7/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
99	30	F	1943	Mogilev ,Ukraina	1/66	2/66	4/66	5/66	7/66	9/66
100	46	M	1943	Birkenau ,Poland	1/66	2/66	5/66	7/66	10/66	11/66
201	77	F	1943	U	6/65	8/65	11/65	1/66		
202	84	F	1943	U	6/65	8/65	10/65	1/66	3/66	6/66
203	70	F	1941	Bershat ,Ukraina	6/65	8/65	10/65	3/66	6/66	10/66
204	66	M	1943	Tashkent ,U.S.S.R.	6/65	8/65	10/65	3/66	7/66	10/66
205	80	F	1943	Mogilev ,Ukraina	6/65	8/65	11/65	1/66	3/66	6/66
206	79	F	1944	Tzyboloika ,Ukraina	6/65	8/65	10/65			
207	60	F	1942	Mogilev ,Ukraina	6/65	8/65	11/65	1/66	3/66	7/66
208	83	F	1943	Transnistria ,Ukraina	8/65	10/65	12/65			
209	53	M	1942	Mogilev ,Ukraina	7/65	9/65	11/65	1/66	5/66	6/66
210	43	F	1941	Bucharest ,Roumania	7/65	9/65	11/65	2/66	4/66	6/66
211		F	1945	Bergen Belsen ,Germany	7/65	9/65	11/65	1/66	4/66	6/66
212	60	F	1942	Transnistria ,Ukraina	7/65	9/65	11/65	3/66	6/66	11/66
213	74	F	1942	Mogilev ,Ukraina	7/65	9/65	11/65	1/66	3/66	11/66
214	74	F	1940	Bucharest ,Roumania	7/65	9/65	1/65	3/66	6/66	

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
218	81	F	1942	Roumania	7/65	1/66	3/66	6/66	11/66	
219	55	F	1943	Uzbekistan	9/65	11/65	1/66	4/66	6/66	9/66
220	67	F	1942	Mogilev	9/65	11/65	1/66	5/66	7/66	12/66
221	59	F	1941	Zamburg	9/65	12/65	1/66	3/66	5/66	7/66
223	44	M	1945	Dachau	9/65	11/65	1/66	3/66	5/66	7/66
224	46	F	1942	Novogrudek	9/65	11/65	1/66	3/66	5/66	7/66
225	38	M	1943	Budzyn	9/65	11/65	1/66	3/66	5/66	8/66
226	41	F	1945	Bergen Belsen	9/65	11/65	1/66	3/66	5/66	9/66
227	64	M	1943	Gracitz	9/65	11/65	1/66	3/66	5/66	7/66
228	56	M	1944	Landsberg	9/65	11/65	3/66	5/66	7/66	9/66
229	58	F	1940	Lublin	10/65	12/65	2/66	4/66	7/66	10/66
230	51	F	1941/2	Strachovitz	10/65	12/65	2/66	4/66	7/66	8/66
233	50	F	1941	Transnistria	10/65	12/65	3/66	5/66	7/66	10/66
234	72	F	1941	Transnistria	10/65	12/65	3/66	5/66	7/66	10/66
235	30	F	1943	Skarzysko	10/65	12/65	3/66	5/66	7/66	10/66
236	1	F	1941	Mogilev	10/65	12/65	3/66	5/66	7/66	9/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding							
					I	II	III	IV	V	VI		
237	56	M	1943	Doroshitz	Ukraine	FLC	10/65	12/65	4/66	6/66	8/66	12/66
238	58	F	1941	Bershat	Ukraine	NCC	10/65	12/65	2/66	4/66	6/66	10/66
239	47	M	1941	Zamosc	Poland	G	10/65	12/65	3/66	5/66	7/66	8/66
240	66	F	1945	Bergen Belsen	Germany	NCC	10/65	12/65	3/66	5/66	10/66	11/66
241	67	F	1942	Balki	Ukraine	G	10/65	12/65	2/66	5/66	7/66	9/66
242	66	M	1943	Auschwitz	Poland	NCC	10/65	12/65	2/66	3/66	6/66	9/66
243	43	M	1943	Starchovitz	Poland	G	12/65	2/66	3/66	6/66	7/66	12/66
246	59	M	1945	Ebensee	Austria	NCC	10/65	12/65	3/66	5/66	7/66	9/66
247	61	M	1942	Lodz	Poland	G	10/65	1/66	5/66	6/66	8/66	12/66
250	54	M	1945	Sovotitze	Yugoslavia	FLC	10/65	12/65	3/66	5/66	7/66	9/66
253	48	F	1942	Auschwitz	Poland	NCC	10/65	12/65	3/66	5/66	7/66	9/66
2	47	F	1945	Bergen Belsen	Germany	NCC	10/65	12/65	2/66	3/66	6/66	9/66
255	58	M	1941	Copaigorod	Ukraine	NCC	10/65	1/66	4/66	6/66	10/66	11/66
256	59	F	1945	Bergen Belsen	Germany	NCC	10/65	12/65	4/66	6/66	8/66	10/66
259	63	M	1941	Miedzyrzecze	Poland	G	10/65	12/65	2/66	4/66	7/66	

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
263	58	M	1944	Kaufering, Germany	NCC	10/65	12/65	2/66	5/66	7/66
265	53	M	1943	Johvi, Estonia	NCC	10/65	12/65	2/66	4/66	6/66
266	37	F	1945	Praust, Poland	NCC	10/65	12/65	2/66	4/66	6/66
267	48	F	1945	Bergen Belsen, Germany	NCC	10/65	3/66	5/66	7/66	9/66
268	52	F	1941	Mogilev, Ukraine	G	10/65	1/66	3/66	5/66	7/66
269	43	F	1944	Blizyn, Poland	NCC	10/65	12/65	2/66	4/66	6/66
270	42	F	1944/5	Bergen Belsen, Germany	NCC	10/65	1/66	3/66	5/66	7/66
272	56	F	1945	Bergen Belsen, Germany	NCC	10/65	12/65	3/66	5/66	7/66
273	36	F	1945	Bergen Belsen, Germany	NCC	10/65	12/65	3/66	5/66	7/66
276	47	M	1943	Doroshitz, Ukraine	FLC	10/65	12/65	2/66	4/66	6/66
277	59	F	1941/2	Mogilev, Ukraine	G	10/65	12/65	2/66	4/66	6/66
278	41	M	1943	Budzyn, Poland	FLC	10/65	2/66	3/66	5/66	7/66
280	58	M	1945	Ebensee, Austria	NCC	10/65	2/66	3/66	5/66	6/66
281	75	M	1944/5	Hildsheim, Germany	FLC	10/65	12/65	3/66	5/66	10/66
282	49	M	1943	Auschwitz, Poland	NCC	10/65	12/65	2/66	4/66	6/66
283	42	F	1941	Transnistria, Ukraine	G	10/65	1/66	3/66	5/66	7/66
										10/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
285	48	F	1943	Stryj, Poland	10/65	1/66	4/66	6/66	7/66	10/66
286	48	F	1945	Launburg, Germany	10/65	12/65	2/66	4/66	6/66	9/66
288	67	F	1942	Transnistria, Ukraine	10/65	1/66	2/66	5/66	7/66	9/66
289	44	F	1942	Transnistria, Ukraine	10/65	1/66	6/66	7/66		
292	51	F	1942	Mogilev, Ukraine	10/65	1/66	3/66	5/66	8/66	10/66
294	36	F	1945	Bucharest, Roumania	11/65	1/66	3/66	5/66	7/66	8/66
295	52	F	1945	Bergen Belsen, Germany	11/65	1/66	3/66	6/66	7/66	9/66
296	64	F	1945	Bergen Belsen, Germany	11/65	1/66	2/66	6/66	9/66	10/66
301	51	M	1943	Buchara, U. S. R.	2/65	5/65	9/65	12/65	2/66	4/66
304	65	F	1943	Mogilev, Ukraine	3/65	10/65	12/65	2/66	5/66	7/66
305	41	M	1944	Austria	5/65	9/65	12/65	2/66	4/66	6/66
306	49	F	W. W. II	Russia	5/65	9/65	12/65	2/66	4/66	6/66
309	45	F	1945	Bergen Belsen, Germany	6/65	9/65	12/65	3/66	5/66	7/66
310	53	F	1942	Uzbekistan, U. S. S. R.	6/65	10/65	12/65	3/66	4/66	6/66
311	55	M	1942	Uzbekistan, U. S. S. R.	6/65	10/65	12/65	3/66	4/66	6/66
401	37	M	1945	Bergen Belsen, Germany	1/66	2/66	3/66	5/66	6/66	9/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
403	43	M	1943	Korshev , U. S. S. R.	FLC	1/66	2/66	3/66	5/66	6/66
405	57	M	1943	Vilishon , U. S. S. R.		1/66	2/66	3/66	5/66	6/66
406	38	M	1940	near Lodg , Poland	FLC	1/66	2/66	3/66	5/66	6/66
407	49	M	1941	Dzambul , U. S. S. R.		1/66	2/66	3/66	5/66	6/66
408	48	M	1941	Chelabinsk , U. S. S. R.		1/66	2/66	3/66	5/66	7/66
409	61	M	1916/7	Vasilov , Poland		1/66	2/66	3/66	5/66	6/66
410	48	F	1936	Bucharest , Roumania		1/66	2/66	3/66	5/66	6/66
413	52	M	1945	Siegendorf , Austria	FLC	1/66	2/66	3/66	5/66	6/66
414	29	M	1941	Mogilev , Ukraine	G	1/66	2/66	3/66	5/66	7/66
415	57	F	1921	Dniepro Pietrovsk, Russia		1/66	2/66	3/66	5/66	6/66
416	39	M	1945	Laumburg , Germany	NCC	1/66	2/66	3/66	5/66	6/66
417	49	M	1943	Turkistan , U. S. S. R.		1/66	2/66	3/66	5/66	6/66
418	56	M	1941	Transnistria , Ukraine	G	1/66	2/66	3/66	5/66	7/66
419	40	M	1941	Trichatay , Ukraine	FLC	1/66	2/66	3/66	5/66	6/66
421	38	M	1943	Narva , Estonia	NCC	1/66	2/66	3/66	5/66	6/66
422	43	M	1942	Anaberg , Germany	NCC	1/66	2/66	3/66	5/66	6/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
423	42	M	1943	Transnistria ,Ukraina ,G	1/66	3/66	6/66	8/66	9/66	10/66
424	46	M	1940/1	Sanok ,Poland ,NCC	1/66	2/66	6/66	8/66	9/66	11/66
426	44	F	1941	Transnistria ,Ukraina ,G	1/66	2/66	3/66	6/66	9/66	10/66
427	59	M	1917	Sosnowiec ,Poland ,Germany ,NCC	1/66	2/66	3/66			
			1944	Langenstein ,U.S.S.R. ,FLC	1/66	2/66	6/66	8/66	9/66	11/66
430	48	M	1942	Archangelsk ,U.S.S.R. ,Russia	1/66	2/66	3/66	6/66	8/66	9/66
432	64	M	1920	Kiev ,Samarkand ,U.S.S.R.	1/66	2/66	3/66	6/66	8/66	9/66
435	41	M	1944	Morava ,Ukraina ,G	1/66	2/66	3/66	6/66	8/66	9/66
436	47	M	1942	Skalat ,Poland ,Roumania	1/66	2/66	3/66	6/66	9/66	10/66
437	61	M	1918/9	Fortitzen ,Roumania ,Iraq	1/66	2/66	3/66	6/66	8/66	9/66
438	66	M	1910	Bagdad ,U.S.S.R.	1/66	2/66	4/66	6/66	7/66	9/66
439	44	M	1935	Transnistria ,Roumania ,G	1/66	2/66	3/66	6/66	8/66	11/66
440	68	M	1944	Kzyl-Orda ,Poland	1/66	2/66	3/66	6/66	8/66	9/66
441	57	M	1943	Novia Oshitz ,Russia	1/66	2/66	3/66	6/66	8/66	9/66
442	58	M	1918							
443	63	M	1920							

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
444	62	M	1914	Krakow, Poland	1/66	2/66	3/66	4/66	7/66	9/66
445	42	M	1945	Lintz, Germany	1/66	2/66	3/66	5/66	7/66	10/66
446	56	M	1943	Tel-Aviv, Israel	1/66	2/66	3/66	4/66	7/66	10/66
447	34	M	1938	Bagdad, Iraq	1/66	2/66	3/66	4/66	7/66	9/66
448	53	M	1951	Lvov, U. S. S. R.	1/66	2/66	3/66	4/66	7/66	9/66
449	56	M	1942	Kazakhstan, U. S. S. R.	1/66	2/66	4/66	5/66	8/66	10/66
451	33	M	1942	Mogilev, Ukraine, G	1/66	2/66	4/66	5/66	9/66	11/66
452	29	M	1941	Sarny, Poland, G	2/66	4/66	5/66	7/66	9/66	12/66
453	52	M	1943	Kiev, Russia	1/66	2/66	4/66	5/66	8/66	9/66
454	44	M	1932	Warsaw, Poland	1/66	2/66	4/66	5/66	8/66	9/66
456	46	M	1942/3	Mogilev, Ukraine, G	1/66	2/66	4/66	5/66	8/66	9/66
457	39	M	1930/1	Alexandria, Egypt	1/66	4/66	5/66	5/66	8/66	9/66
458	34	M	1942	Copaigorod, Ukraine, NCC	1/66	2/66	4/66	5/66	8/66	9/66
459	37	M	1938	Sanaa, Yemen	1/66	2/66	5/66	5/66	8/66	11/66
461	39	M	1919	Ispahan, Persia	1/66	2/66	5/66	5/66	9/66	11/66
462	61	M	1919	Samarckand, U. S. S. R.	1/66	2/66	4/66	5/66	8/66	9/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
463	36	M	1943	Transnistria, Ukraine	1/66	2/66	5/66	7/66	9/66	10/66
465	48	M	1943	Buchenwald, Germany	1/66	2/66	4/66			
466	59	M	1920	Iassy, Roumania	1/66	2/66	4/66	5/66	7/66	10/66
467	60	M	1949	Roumania	1/66	2/66	4/66	5/66	7/66	9/66
469	29	M	1941/2	Istanbul, Turkey	1/66	2/66	4/66	5/66	7/66	9/66
470	46	M	1942	Vilno, Poland	1/66	2/66	4/66	5/66	7/66	9/66
473	46	M	1942	Copaigorod, Ukraine	1/66	2/66	4/66			
474	49	M	1943	Davidka, Russia	1/66	4/66	5/66	8/66	9/66	12/66
476	55	M	1941	Bershat, Ukraine	1/66	2/66	4/66	5/66	7/66	9/66
480	43	M	1945	Dachau, Germany	1/66	2/66	3/66	6/66	7/66	10/66
481	44	M	1944	Gunskirchen, Germany	1/66	2/66	3/66	6/66	7/66	8/66
482	39	M	1945	Bergen Belsen, Germany	1/66	2/66	3/66	5/66	6/66	9/66
483	40	M	1940	Bagdad, Iraq	1/66	2/66	3/66	5/66	7/66	10/66
484	37	M	1942	Samarkand, U. S. S. R.	1/66	2/66	3/66	5/66	6/66	8/66
485	43	M	1943	Auschwitz, Poland	1/66	2/66	3/66	5/66	6/66	9/66
486	42	M	1945	Kaufering, Germany	1/66	2/66	3/66	6/66	8/66	9/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
488	43	M	1944	Landsberg, Germany	NCC 1/66	3/66	4/66	6/66	8/66	10/66
489	22	F	1946	Bagdad, Iraq	1/66	3/66	4/66	6/66	8/66	10/66
490	48	M	1942	Borky Wielky, Ukraine	NCC 1/66	3/66	4/66	6/66	8/66	10/66
491	46	M	1941	Kazakhstan, U. S. S. R.	1/66	3/66	4/66	7/66	8/66	10/66
492	35	M	1945	Morocco	1/66	3/66	5/66	6/66	7/66	9/66
494	48	M	1942	Skarzysko, Poland	NCC 1/66	3/66	5/66	7/66	7/66	9/66
495	38	M	1943	Transnistria, Ukraine	G 1/66	3/66	5/66	6/66	7/66	9/66
496	60	M	1941	Transnistria, Ukraine	G 1/66	3/66	5/66	6/66	7/66	9/66
497	59	M	1925	Sofia, Bulgaria	1/66	3/66	5/66	6/66	9/66	11/66
498	55	M	1942	Transnistria, Ukraine	G 1/66	3/66	5/66	6/66	6/66	6/66
499	44	M	1942	Transnistria, Ukraine	G 1/66	3/66	5/66	7/66	9/66	11/66
502	63	M	1922	Tel-Aviv, Israel	2/66	3/66	5/66	6/66	8/66	9/66
503	61	M	1942	Auschwitz, Poland	NCC 2/66	3/66	5/66	6/66	6/66	11/66
504	45	M	1942	Transnistria, Ukraine	G 2/66	3/66	5/66	6/66	10/66	11/66
505	44	M	1949	Charkov, Russia	2/66	3/66	5/66	6/66	9/66	10/66
506	53	M	1942	Transnistria, Ukraine	2/66	3/66	5/66	6/66	9/66	10/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					1	II	III	IV	V	VI
507	39	M	1944/5	Buchenwald, Germany	2/66	5/66	7/66	8/66	10/66	12/66
509	59	M	1942	Tashkent, U. S. S. R.	2/66	3/66	5/66	6/66	8/66	11/66
511	56	M	1942	Transnistria, Ukraine	2/66	3/66	5/66	6/66	8/66	10/66
512	50	M	1945	Dachau, Germany	2/66	3/66	5/66	7/66	10/66	11/66
513	47	M	1942	Transnistria, Ukraine	2/66	3/66	5/66	7/66	10/66	11/66
514	52	F	1920	Nowidwor	2/66	3/66	5/66	6/66	9/66	10/66
515	41	F	1945	Bergen Belsen, Germany	2/66	3/66	5/66	8/66	9/66	10/66
516	47	F	1932	Tashkent, U. S. S. R.	2/66	5/66	6/66	8/66	9/66	10/66
517	41	M	1942	Archangelsk, U. S. S. R.	2/66	3/66	5/66	8/66	10/66	11/66
518	66	M	1922	Lvov, Poland	2/66	3/66	5/66	6/66	8/66	10/66
520	57	F	1913/4	Warsaw, Poland	2/66	3/66	5/66	6/66	9/66	10/66
603	40	F	1943	Degania, Israel	6/65	8/65	12/65	4/66	6/66	11/65
604	45	M	1942	Tashkent, U. S. S. R.	5/65	7/65	11/65	1/66	3/66	5/66
605	38	M	1942	Buchara, U. S. S. R.	5/65	7/65	11/65	1/66	4/66	6/66
606	41	F	1942	Buchara, U. S. S. R.	5/65	10/65	1/66	7/66	10/66	12/66
607	59	M	1943	Suzak, U. S. S. R.	5/65	8/65	11/65	1/66	3/66	5/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
705	49	M	1916	Transsylvania, Roumania	3/65	5/65	9/65	10/65	2/66	4/66
721	40	M	W. W. II	NCC	9/65	10/65	11/65	6/66	6/66	7/66
767	56	F	1945	Kolkai, Germany	4/66	4/66	6/66	6/66	6/66	6/66
801	44	F	1945	Bergen Belsen, Germany	1/66	2/66	3/66	5/66	7/66	9/66
803	48	F	1945	Bergen Belsen, Germany	NCC	1/66	2/66	5/66	6/66	8/66
804	51	F	1945	Bergen Belsen, Germany	NCC	1/66	3/66	6/66	7/66	9/66
805	43	F	1940	Warsaw, Poland	G	1/66	3/66	7/66	7/66	11/66
806	51	F	1942	Lvov, U. S. S. R.	G	1/66	2/66	3/66	5/66	7/66
808	46	M	1943	Blizyn, Poland	NCC	1/66	3/66	6/66	10/66	11/66
810	35	F	1941	Gadu-Tripoli, Lybia	1/66	2/66	4/66	6/66	7/66	9/66
811	65	M	1917	Piatrnitz, Roumania	1/66	2/66	4/66	6/66	8/66	9/66
812	52	M	1945	Gunskirchen, Germany	NCC	1/66	2/66	4/66	6/66	7/66
814	44	M	1941	Gadu-Tripoli, Lybia	1/66	3/66	5/66	6/66	8/66	9/66
815	48	F	1941	Gadu-Tripoli, Lybia	1/66	3/66	4/66	6/66	7/66	9/66
816	56	M	1942	Treptca, Poland	NCC	1/66	2/66	4/66	6/66	7/66
817	46	M	1943	Russia	1/66	2/66	4/66	6/66	7/66	9/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Reeding					
					I	II	III	IV	V	VI
818	38	M	1941/2	Radom , Poland	'G	1/66	2/66	4/66	6/66	7/66
819	40	M	1945	Gunskirchen , Germany	, NCC	1/66	3/66	5/66	6/66	8/66
820	39	F	1941	Gadu-Tripoli , Lybia		1/66	2/66	4/66	6/66	8/66
821	51	M	1944/5	Horlou , Roumania		1/66	2/66	4/66	6/66	7/66
822	65	F	1917	Poland		1/66	2/66	4/66	6/66	9/66
824	43	F	1944	Landsberg , Germany	, NCC	1/66	4/66	6/66	7/66	9/66
826	55	M	1945	Siegedorf , Austria	, FLC	1/66	2/66	4/66	6/66	7/66
827	51	F	1945	Bergen Belsen , Germany	, NCC	1/66	2/66	4/66	6/66	7/66
828	57	M	1945	Bergen Belsen , Germany	, NCC	1/66	2/66	4/66	6/66	7/66
829	40	F	1945	Mathahausen , Aust	, NCC	1/66	2/66	4/66	6/66	7/66
830	45	F	1945	Kolkai , Germany		1/66	2/66	5/66	6/66	8/66
831	44	F	1945	Bergen Belsen , Germany	, NCC	1/66	2/66	4/66	6/66	7/66
832	48	F	1945	Gunskirchen , Germany	, NCC	1/66	2/66	4/66	6/66	7/66
833	52	F	1945	Flossenborg , Germany	, NCC	1/66	2/66	4/66	6/66	7/66
834	60	M	1941	Vlodava , Poland	, G	1/66	3/66	4/66	6/66	7/66
835	51	F	1941	Vlodava , Poland	, G	1/66	3/66	4/66	6/66	7/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL

LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					I	II	III	IV	V	VI
836	47	F	1943	Blizyn, Poland	1/66	2/66	4/66	6/66	7/66	9/66
837	38	M	1945	Theresienstadt, Czechoslovakia, NCC	1/66	2/66	4/66	6/66	7/66	8/66
838	54	F	1943	Warsaw, Poland	G	1/66	2/66	4/66	6/66	7/66
839	40	M	1943	Blizyn, Poland	NCC	1/66	2/66	4/66	6/66	7/66
840	58	F	1942	Poutasscha, Ukraine	N, C	1/66	3/66	4/66	7/66	8/66
841	46	M	1945	Flossenbürg, Germany	NCC	1/66	2/66	4/66	6/66	7/66
842	37	F	1945	Bergen Belsen, Germany	NCC	1/66	3/66	5/66	6/66	8/66
844	35	M	1945	Lintz, Germany	NCC	1/66	3/66	5/66	6/66	9/66
845	44	M	1945	Siegendorf, Austria	FLC	1/66	3/66	4/66	6/66	7/66
846	40	M	1945	Bergen Belsen, Germany	NCC	1/66	3/66	4/66	6/66	9/66
847	46	M	1944	Bergen Belsen, Germany	NCC	1/66	3/66	4/66	6/66	7/66
848	47	F	1945	Bergen Belsen, Germany	NCC	1/66	3/66	4/66	6/66	7/66
849	52	M	1943	Prisoners Camp, Russia		1/66	3/66	4/66	6/66	7/66
850	44	M	1945	Welsch, Austria		1/66	3/66	4/66	6/66	7/66
851	45	M	1945	Seschaup, Germany		1/66	3/66	4/66	6/66	8/66
853	45	F	1941/2	Lodz, Poland	G	1/66	3/66	5/66	7/66	9/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
LIST OF VOLUNTEERS

Case No.	Age	Sex	Year of Onset	Place of Attack of Epidemic Typhus	Month and Year of Bleeding					
					1	II	III	IV	V	VI
854	46	M	1940	Ostrowitz , Poland	G	1/66	4/66	6/66	7/66	9/66
855	44	F	1943	Auschwitz , Poland	NCC	2/66	3/66	4/66	7/66	8/66
856	46	M	1940	Piotrkow Trybunalski, Poland	G	2/66	3/66	4/66	6/66	8/66
857	37	F	1941	Mogilev , Ukraine	G	2/66	4/66	5/66	7/66	9/66
858	56	M	1945	Hidegseg , Hungary	NCC	2/66	3/66	4/66	6/66	7/66
859	60	F	1945	Lichtenwerth , Austria	NCC	3/66	4/66	6/66	7/66	9/66
860	54	F	1940	Warsaw , Poland	G	3/66	4/66	5/66	7/66	9/66
										11/66

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
4	20/20	4/10	20/20				32	32	32	16	16	32
7	20/20	20/20	20/20	20	20	20	32	16	32	16	16	16
10	20/20	20	<10	<10	<10	<10	16	16	16	16	16	16
11	<10	20/20	<10	<10	<10	<10	16	32	32	<2	<2	<2
12	20/20	20/20	<10	10/10	<10	<10	<2	<2	<2	<2	<2	<2
13	20	20/20	20	10	20	20	16	16	16	16	16	16
14	40	20	20	20	20	10	32	32	32	32	32	32
20	40/20	40	20	20	20	20	16	8	16	16	16	16
21	10	20/20	20	20	80	80	256	128	128	256	256	256
22	20/10	20/20	10	<10	<10	<10	8	8	8	8	8	8
23	10/10	10/10	<10	<10	<10	<10	16	8	8	8	8	8
25	20/20	20/20	20/20	<10	<10	<10	<2	<2	<2	<2	<2	<2
26	80	80	40	80	80	80	64	64	64	64	64	64
27	<10	<10	<10	<10	<10	<10	8	8	8	16	16	16
28	<20	20	20	<20	20	<20	16	16	16	16	16	16
30	20	20	20	20	40	20	16	16	16	16	16	16

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *					MA RESULTS				
	I	II	III	IV	V	I	II	III	IV	V
36	20/20	10/10	10/10	<10	<10	4	4	8	4	4
38	10/10	<10	<10	<10	<10	32	16	16	32	16
39	10/10	20	20	80	10	128	128	128	128	128
40	20/20	20/20	<10	<10	<10	8	8	16	8	16
42	20/20	<10	<10	10	<10	2	<2	<2	64	16
43	20	<20	20	20	<20	16	16	16	32	32
44	<10	<10	<10	<10	<10	32	32	32	32	32
45	20/10	20	20	20	20	32	32	32	32	32
46	40	20	40	40	20	64	64	64	64	64
47	20/20	20	20/10	20	20	32	64	64	32	32
49	20/20	20/20	<10	20/20	10	16	8	16	16	8
50	20/20	20/20	20/20	<10	<10	4	4	4	4	4
51	20/20	20	<10	<10	<10	4	4	4	2	4
52	40/40	20	20	20	20	16	16	8	16	8
53	20/20	40/20	40/20	<10	10	3	4	4	4	4
55	20/20	10/10	10/10	<10	10	3	4	4	4	4

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

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 SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
 EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *					MA RESULTS				
	I	II	III	IV	V	I	II	III	IV	V
57	40	40	40	20	40	40	256	128	128	64
58	40	40/20	20/10	20/10	<10	20	16	16	16	16
59	40/20	40/20	20/20	20/20	10/10	10	8	8	8	8
60	40	20/20	20	20	20	20	16	16	16	16
61	40	20/10	20	20	20	20	64	64	64	64
64	40/20	20/10	20	20	20	20	16	16	16	16
66	40	20	20/10	20/10	20/10	20	16	16	16	16
67	40	20	20	20	20	20	16	16	16	16
69	20/10	20/10	<10	20/10	<10	<10	8	16	16	8
70	20/10	20/10	20/10	20	20	20	8	16	16	8
71	20/20	20/20	20/20	20/20	10/10	<10	8	8	8	16
72	20/20	20	20/20	20	20	20	16	16	16	16
73	20/10	20/10	20/10	20/10	10	<10	16	16	8	8
74	40/40	20/20	20/20	20/20	20	<10	32	64	64	64
76	20/20	<10	20/20	20/20	<10	<10	<2	2	2	<2
77	40/20	40/20	<10	20/20	<10	20/20	16	16	16	16

* RECIPROCAL OF SERUM TITER
 ANTI-COMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL

EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
78	40/20	20	20/20	20/20	20	20	8	8	8	16	8	8
79	20	20	20	20	20	20	32	32	32	64	64	16
81	20/10	20/10	20	<10	<10	<10	16	16	16	16	16	16
82	20	40	20/10	20/10	20	40	16	16	32	32	32	32
83	40	20/10	20/10	20/10	20/10	20	16	32	32	32	16	32
84	20/10	40/20	40	20	10	20	16	16	16	16	16	16
85	20/20	<10	<10	<10	<10	<10	<2	<2	<2	<2	<2	<2
86	40/20	20/20	20/20	20/20	<10	<10	32	32	16	16	32	16
87	20/10	20/10	40	20/10	20	20	32	32	32	32	32	32
88	20/10	20/10	20/10	10	10	10	8	16	16	8	8	16
89	20	20/10	20/10	20	10	20	8-16	8-16	8-16	8-16	8-16	8-16
90	20/10	40	20	20	20	20	32	32	64	64	32	32
92	40/20	80/40	20	20/10	20/10	20	64	64	64	64	64	64
93	20/10	20/10	20/10	20/10	20	20	16	16	16	16	32	32
94	<10	20/10	10/10	<10	<10	<10	<2	<2	<2	<2	<2	<2
95	40/20	20/10	40	20/10	20/10	20	32	32	16-32	16-32	16-32	16-32

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *					MA RESULTS				
	I	II	III	IV	V	I	II	III	IV	V
99	20/10	20/10	20	20/10	<10	10	32	64	64	32
100	20/10	20	20/10	<10	<10	<10	16	32	32	32
201	<10	20/10	20/10	20/10	<10	<10	8	8	8	8
202	<10	20	<10	<10	<10	<10	16	16	2	<2
203	10	10	10	<10	<10	<10	16-32	16-32	16-32	16-32
204	20/10	20/10	20/10	<10	20/10	<10	32	32	16	16
205	<10	<10	<10	<10	<10	<10	16	16	16	16
206	10	10	20	<10	<10	<10	32	32	64	16
207	<10	<10	<10	20	<10	<10	32	32	16	16
208	20/10	40/20	20/10	20/10	<10	<10	8	8	8	4
209	<10	<10	<10	<10	<10	<10	32	32	32	64
210	<10	<10	<10	<10	<10	<10	<2	<2	<2	<2
211	10/10	20/10	20/10	40/20	40/20	10/10	2	2	2	4
212	<10	<10	<10	<10	<10	<10	16	8	4	8
213	40	40	20	40	40	20	32	32	32	16
214	<10	<10	<10	<10	<10	<10	2	2	2	4

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
218	40/20	40/20	40/20	20	20	40/20	32	32	32	32	32	32
219	20/10	40/20	40/20	40/20	20/20	<10	8	4	8	8	8	8
220	20/10	<10	<10	<10	<10	<10	8	6	8	32	16	16
221	20/10	10	20	20	20/10	20	16	16	16	8	16	16
223	10/10	<10	20/10	10	20/10	20/10	8	8	16	8	16	8
224	20/20	10/10	20/20	20/20	20/20	20/20	8	8	16	8	8	8
225	40/20	40	40/20	40/20	40/20	20	32	16	16	16	16	64
226	40	40	40/20	40	40	40	32	16	32	32	16	16
227	<10	<10	<10	20/20	<10	<10	8	4	2	4	8	8
228	40/20	20/10	<10	<10	40	10/10	2	2	2	4	8	16
229	20/10	20/10	20/10	20/10	20/10	20/10	16	16	16	16	16	16
230	20/10	26/10	20/10	20/10	20/10	10	16	32	32	32	16	16
233	40/20	80/40	40/20	20/20	10	10	16	16	8	8	<2	<2
234	40/20	40/20	10	20	20/10	20/10	<10	8	16	16	8	8
235	<10	20/10	20/10	20/10	20/10	20/10	40	40	128	128	64	32
236	80	80	40	40	40	40	128	128	64	64	32	32

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
237	40	20/10	40	40	20	20	64	128	64	64	64	64
238	20/10	20/10	20/10	40/20	40/20	20	32	32	32	32	16	16
239	10	20/10	10	20	20	10	32	32	32	32	16	16
240	40	40	20/10	20/10	20	20	32	32	64	32	32	32
241	40/20	40/20	40/20	<10	<10	<10	16	16	16	16	16	16
242	40/20	40/20	20/20	20/10	20/20	20/10	4	4	4	4	4	4
245	20/20	20/20	20/20	<10	20/20	20/20	8	4	8	8	4	8
246	20/10	20/10	20/10	40/20	20/20	<10	2	2	2	2	<2	<2
247	20/10	20/10	20/10	20/10	20	20	32	16	16	16	16	16
250	40/20	40/20	40/20	40/10	20	20	64	64	64	64	64	64
251	20/20	20/20	20/20	20/20	20/20	10	16	16	16	16	16	16
252	20/20	40/20	20/20	<10	<10	<10	8	8	8	8	8	8
253	20/20	20/20	20/20	<10	<10	<10	8	8	8	8	8	8
255	20/10	20/10	40/10	40/20	40/20	40/20	16	16	16	16	16	16
256	20/10	20	20	20	40	40	8	16	8	8	4	2
259	20/10	20/10	40/20	80/40	10/10	8	8	8	8	8	8	8

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
263	40/20	40	40/20	40	40	40	64	64	64	32	32	32
265	40/20	20/20	20/20	20/20	20/20	<10	8	8	8	8	8	8
266	40/20	40/20	40/20	40/20	40	20	16	32	32	32	32	32
267	40/20	40/20	40/20	40/20	40/20	20	64	32	32	32	32	32
268	10	20/20	40/20	40/20	20	40	128	128	128	128	128	128
269	20/10	20/10	20/10	20/10	40	20	16	16	16	16	16	16
270	20/10	20/10	20/10	40/20	20	20/10	16	16	16	16	16	16
272	40	40	40	40/20	40	40	32	32	32	32	32	32
273	20/10	20/10	20/10	20/10	10	20/10	8	8	8	8	8	16
276	10	20/10	20/10	20/10	20/10	40/20	32	32	32	32	32	32
277	10/10	80	80/40	20/10	80/40	<10	<2	2	<2	2	2	2
278	80/40	40/20	80/40	80/40	40/20	40/20	16	32	32	32	32	16
280	20/10	40/20	20/10	40/20	40/20	20	16	16	16	16	16	16
281	10/10	20/10	10/10	80/10	40/20	40/20	2	2	2	4	4	4
282	20/10	80/10	40/10	80/10	40/20	40/20	4	4	4	4	4	4
283	40/20	40/20	40/20	40/20	40/20	<10	8	8	4	4	4	4

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *					VI	MA RESULTS				
	I	II	III	IV	V		I	II	III	IV	V
285	40/20	40/20	80	40	40/20	<10	16	8	32	32	32
286	10/10	20	20/10	20/10	20/10	20/10	4-8	4-8	4	2	2
288	20/10	<10	40/20	<10	<10	<10	2	2	2	4	4
289	10	10	20	20	20	20	16	16	32	32	32
292	10/10	<10	20/10	40/20	40	<10	32	32	32	32	32
294	20/10	20/10	40/20	20	20	80/40	32	32	32	32	32
295	40/20	40/20	40/20	40/20	40	<10	32	32	32	16	16
296	20/10	40/20	40/20	20/10	40/20	40/20	4	8	8	16	8
301	40	40/20	20/10	10	20/10	20/10	16	16	16	16	16
304	<10	20/10	40/20	20/10	20/10	40/20	8	16	16	16	16
305	20/10	20	20/10	<10	40	20/10	128	128	128	128	256
306	20/10	<10	20/10	20/10	<10	<10	64	64	64	64	128
309	40/10	40/10	80/10	80/10	80/10	40/10	256	128	128	128	256
310	20/10	20/10	20/10	20	10/10	20/10	8	16	8	8	8
311	20/10	20	20/10	20/10	10	10	32	32	32	32	32
401	20/10	20/10	20/10	20/10	20/10	20/10	32	16	8	8	8

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *					MA RESULTS						
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
403	20/10	20/10	20/10	20/10	20/10	10	16	16	64	64	64	32
405	40/20	40/20	20/10	20/10	40/20	40/20	2	2	16	8	16	8
406	40/20	20/10	20/10	40	40	40	16	16	16	16	16	16
407	10	20/10	20/10	10	20/10	20	8	8	8	8	8	8
408	20/20	20/20	20/20	20/20	20/20	20	64	32	32	64	64	64
409	20	20/10	20/10	40/20	40/20	40	32	32	32	32	32	32
410	20	20	20/20	40/20	40/20	40	16	16	16	16	16	16
413	20	20	20	40	40	20	64	64	64	64	32	32-64
414	40/10	40/10	80/10	40	40	20	8	8	16	8	8-16	16
415	40	40/20	20/20	20/10	40/20	20/10	32	32	32	32	32	32
416	80	80	40	40	40	40	16-32	16-32	16	32	16	16
417	40	40/20	40/20	20/10	20/10	20	16-32	16	16	16	16	16
418	20	20	40	40/20	20/10	20	64	64	64	32-64	32-64	32-64
419	40/20	40/20	20	40	40	40	64	64	64	32	32-64	32-64
421	<10	40/20	20/10	10	20	<10	64	64	64	32	32-64	32-64
422	10	<10	40/20	40/10	40/20	40/20	16	16	32	16	16	16

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
423	20/20	<10	40/20	<10	<10	<10	4	2	2	4	4	2
424	20/10	20	10	20	10	10	16	32	8			
426	20/20	20/20	10	10	20	10	32	32	16	16	16	16
427	20/10	20	10				16	16	8			
430	20/10	20/10	<10	<10	<10	<10	2	2	8	8	8	8
432	40/20	20/20	20/20	20/20	20/20	20	16	16	16	16	8	16
435	40	40	40	40	20	20	64	64	64	128	64	64
436	40/20	20	20/10	40	20/10	20	32	32	32	32	32	32
437	40	40	40/20	20	20	20	32	32	32	32	32	32
438	40/20	40/20	40/20	20/10	20/10	20	16	16	16	16	16	16
439	40/20	20/10	20	10	20	20	8	8	8	8	8	8
440	40/20	40/20	40/20	20/10	40/20	40/20	8	8	8	8	8	8
441	40/20	20/10	20	40	20	20	64	64	64	64	32	32
442	20/10	20/10	20/10	20/10	40/20	<10	8	8	8	4	8	8
443	40/20	40	40/20	40	20	20	32	32	32	32	32	32
444	<10	40/20	40/20	10	20/10	<10	16	16	16	16	16	16

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
445	40/10	40/10	40/10	40/10	10	20	64	32	32	64	64	64
446	40/20	40/20	40/20	20/10	<10	<10	<2	<2	<2	<2	<2	<2
447	20/10	20/10	20/10	20/10	10/10	<10	<2	<2	<2	<2	<2	<2
448	20/10	10/10	20/20	20/20	10/10	<10	<2	<2	4	2	2	2
449	20/10	20/10	10	10	10	<10	8	8	8	8	8	8
451	40/20	<10	10/10	<10	<10	<10	8-16	8-16	8	8	8	8
452	40	20/10	20/10	10	20/10	10	32	32	32	32	32	32
453	40	20/10	40	40	10	20	32	32	32	32	16	16
454	40	40	20/10	10	<10	20/10	16	64	32	16-32	16-32	16-32
456	20/10	10/10	10	<10	<10	20/10	128	128	64	64	64	64
457	20/10	20/10	20/10	20/10	20/10	20/10	4	2	2			
458	40/20	40/20	40/20	40/20	40/20	40/20	32	16	16	16	16	16
459	20/10	20/10	20	20								
461	20/10	20/10	<10	<10	20/10	20/10	4	8	16	16	32	32
462	20/10	20/10	20/10	10	20/10	10	4	16	8	4		
463	40/20	20/10	20/10	10	10	10						

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
465	20/10	20/10	20/10	20/10	<10	<10	8	32	16	64	64	64
466	20/10	20/10	10	20/10	<10	20/10	128	128	128	32-64	64	64
467	40/20	40/20	20/10	<10	<10	20/10	<2	<2	<2	<2	<2	<2
469	10	20/10	20/10	10/10	<10	<10	<2	<2	<2	<2	<2	<2
470	40/20	80/10	40/20	40	40	40	64	64	32	128	128	128
473	40	40	40	40	40	40	128	128	64	128	128	128
474	40/20	40/20	20	<10	20	20	16	16	16	4	8	16
476	40	40	20	20	20	20	16	64	64	32	32	32
480	40	20	20/10	20	20	10	16	16	16	16	32	16
481	40	40/20	20/10	40/20	40/20	20	64	64	64	64	128	64
482	40	20	20/10	20/10	40/20	20	32	32	32	32	32	32
483	20/10	20/10	10/10	10/10	10/10	<10	2	2	2	2	2	2
484	20/10	20/10	20/10	20/10	20/10	<10	32	32	32	32	32	32
485	20/10	40/20	20/10	40/20	20/10	20/10	8	16	8	8	8	8
486	20/10	40/20	20	20	20	10	8	8	8	16	8	8
488	20/10	20/10	20/10	20/10	20/10	10	8	8	8	8	8	8

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *					MA RESULTS						
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
489	10/10	10/10	<10	20/10	20/10	<10	8	8	8	8	6	6
490	40/20	40/20	40/20	20	20/20	20	16	16	64	64	64	64
491	40/20	40/20	20/20	10	10	10	32	16	16	16	16	16-32
492	40/20	40/20	20/20	40/20	<10	40/20	2	2	2	2	2	2
494	20/20	40/20	40/20	40/20	10/10	20/20	16	16	16	16	16	16
495	40/20	40/20	20/20	20/20	20	20	16	16	32	32	32	32
496	20/10	20/10	20/10	<10	<10	<10	<2	<2	<2	<2	<2	<2
497	20/10	20/10	40/20	40/20	<10	<10	<2	<2	<2	<2	<2	<2
498	80/10	40/10	80/10	40/10	40/10	<10	32	32	16	16	16	16
499	40/20	<10	<10	10	10	10	16	16	16	16	16	16
502	<10	<10	20/10	20/10	<10	<10	<2	<2	<2	<2	<2	<2
503	20/10	20	20	<10	<10	<10	64	64	2	2	2	2
504	20/10	20/10	20/10	20/10	<10	<10	2	4	2	2	2	2
505	20/10	20/10	20/10	20/10	<10	<10	4	2	2	2	2	2
506	20/10	20/10	20/10	20/10	20/10	<10	<2	<2	<2	<2	<2	<2
507	20/10	20/10	20/10	10	<10	<10	<2	<2	<2	<2	<2	<2

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
509	20/10	20/10	20/10	20/10	<10	<10	4	4	4	4	4	4
511	20/10	20/10	20/10	20/10	<10	<10	8	8	16	8	8	8
512	20/10	20/10	20/10	20/10	40/20	20/10	2	2	2	2	2	2
513	20/10	<10	<10	20/10	20/10	<10	16	16	16	16	16	16
514	<10	10/10	20/10	20/10	<10	10	16	16	16	16	16	16
516	20/10	<10	40/20	<10	<10	<10	<2	<2	<2	<2	<2	<2
517	20	40/20	20/10	20	20	20	16	16	16	16	16	16
518	20/10	20/10	40/20	<10	<10	<10	8	8	8	8	8	8
520	40/20	20/10	<10	20/10	<10	<10	2	8	8	8	8	8
603	40/20	20/10	20/10	20/10	20	10	32	32	32	32	64	64
604	20/10	20/10	20/10	20/10	20/10	20/10	32	32	32	32	32	32
605	40	20/10	20	20/10	40/10	80/10	16	16	16	16	16	16
606	10	20	10	20	20	10	32	64	32	32	32	32
607	40/20	80	80	80	40	40/20	128	64	128	256	128	256
705	20/10	20/10	20/10	20/10	20/10	10	<2	8	4	16	8	4
721	20/20	20/20	<10	<10	<10	<10	2	<2	<2	<2	4	<2

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL

EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGREGATION (MA) TEST

CF RESULTS *

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
767	10/10	<10	10	10	10	10	8	8	8	8	8	8
801	10/10	40/20	20/10	20/10	20/10	<10	16	16	16	32	32	32
803	40/20	40	20	20	20	20	64	64	64	32	32	32
804	40	40	20	20	20	20	64	64	64	64	64	64
805	20/10		40	20			32		16	32		
806	20	20	20/10	20/10	<10	20	32	32	32	32	32	32
808		20/10	20/10	20/10	<10	<10		16	16	16	32	32
810	20/10	20/10	20/10	<10	<10	<10	4	4	4	4	4	4
811	40	20	40	20	40	20	32	32	32	32	32	32
812	40	20	20	20	20	20	64	64	64	64	64	64
814	40	40	40	40	40	20	64	64	64	128	64	64
815	20/10	20/10	20/10	20/10	20/10	20/10	8	8	8			
816	20/10	10	20/10	20/10	20/10	20/10	<2	<2	4	<2	<2	<2
817	40/20	20/10	20/10	20/10	20/10	20/10	32	32	16	16	32	32
818	20/20	20/10	<10	20/10	20/10	<10	32	32	32	16	32	32
819	20/10	20	20/10	<10	20/10	<10						

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
820	10/10	<10	20/10	<10	20/10	<10	20/10	16	16	16	16	16
821	20/20	20/10	20/10	20/10	20/10	<10	<10	2	<2	<2	<2	<2
822	20/10	20/10	20/10	<10	<10	<10	20/20	16	16	16	16	16
824	20/20	20/20	20/20	<10	<10	<10	20/20	128	128	128	128	64
826	40	40	40	20	20	40	128	128	128	128	128	64
827	20/10	20/10	20/10	20/10	20	10	10/10	32	32	32	32	32
828	10/10	10/10	10/10	10/10	10/10	10/10	<2	<2	<2	4	4	4
829	20/10	40	20	40	40	20	64	64	64	64	64	64
830	40/10	40/10	80/10	40/10	40	40	256	256	128	128	128	128
831	20/10	40/20	20/10	20/10	20/10	10	32	32	32	32	32	32
832	20	40/20	40	40	20	20	32	32	32	64	64	32-64
833	20/10	20/10	20/10	20/10	20	20	32	32	32	32	32	32
834	20/10	20/10	20/10	20/10	20	20	32	16	16	16	16	16
835	20/10	20/10	20/10	20/10	20/10	20/10	32	16	16	16	16	16
836	40	20	20	20	20	20	32	32	32	64	64	64
837	20/10	20	20	20	20	20	16	16	16	16	16	16

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGLUTINATION (MA) TEST

Case No.	CF RESULTS *					MA RESULTS						
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
838	20/10	20/10	20/10	<10	<10	<10	4	4	4	4	4	4
839	20/10	40	20/10	20	10	10	8	16	8	16	8	8
840	20	20	20	20	20	20	64	64	64	64	64	64
841	20/10	20/10	40/20	40/20	<10	<10	8	4	4	4	4	4
842	40	80/40	40/20	40	40	40	32	32	64	64	64	64
844	20	20	20/10	20	20/10	20	16	16	16	16	16	16
845	20/10	20/10	20/10	10	40/20	40/20	8	8	8	8	16	16
846	40/20	40	20/10	20	20	20	128	128	128	128	128	128
847	40/20	40	20/10	20/10	10	<10	256	256	64	64	32	64
848	40/20	40/20	40	20	40	20	32	32	32	32	32	32
849	40/20	20/20	20/20	40	20/20	20	32	32	32	32	37	32
850	20	20/10	20	20	20	20	128	64	32	32	32	32
851	40	40	40	20	20	20	16	16	16	16	16	16
853	<10	20/10	20/10	10	10	20/10	8	8	16	16	16	16
854	80	40/10	40	80	20	40	128	64	32	32	64	64
855	40/20	40/20	40/20	40/20	40	40/20	32	32	64	32	64	32

* RECIPROCAL OF SERUM TITERS
 ANTICOMPLEMENTARY SERUM TITERS

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SURVEY OF RECRUDESCENT TYPHUS IN ISRAEL
EPIDEMIC TYPHUS COMPLEMENT FIXATION (CF) AND MICROAGGREGATION (MA) TEST

Case No.	CF RESULTS *						MA RESULTS					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
856	40	40	40	40	80	40	128	256	128	256	128	128
857	40	80	80	20	80	40	32	32	32	32	32	32
858	80	80	80	40	10							
859	40/20	20	10	10	40	20						
860	20/10	20	20	20	20	20	32	32	32	32	32	32

* RECIPROCAL OF SERUM TITER
ANTICOMPLEMENTARY SERUM TITER

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APPENDIX C

A computational method for assessment of the effect of anti-complementary substances on the estimated titer was worked on in our laboratory. An assumption was made that the effect of AC substances on the estimated titer value is a quantitative rather than a qualitative one. Namely, under this assumption a CF titer of 80 and an AC titer of 20 that is usually considered to be equal to a titer of 80 should be regarded as a smaller value, since even in a dilution of 80, the AC substances in a titer of 20 will prevent some of the complement molecules from causing lysis.

Based on mathematical derivations (to be published) it was found that the specific antibody titer should be the antibody titer that was estimated in presence of AC substances minus the AC titer. Namely, a specimen with a titer of 80/20 should be accordingly regarded as having a specific antibody titer of $80-20=60$.

APPENDIX D

As mentioned in the text of the Final Technical Report, sera obtained from volunteers were divided into equal lots one of which was sent to Dr. Charles L. Wisseman, Jr. (Head and Professor, Department of Microbiology, University of Maryland School of Medicine, Baltimore, Md.), for serological testing to be carried out in parallel to tests in Ness-Ziona.

To facilitate the comparison of the serological results obtained in the two laboratories, the same materials were used and the same methods applied: the standard microcomplement-fixation (CF) technique and the microagglutination (MA) test. The only difference was in that the starting dilution in the CF tests performed in Dr. Wisseman's laboratory was 1:2 whereas in the Ness-Ziona laboratory it was 1:10.

The serological results obtained in Dr. Wisseman's laboratory and the comparison of his results with those obtained in our Institute are summarized in the tables enclosed.

1. Results Obtained in Dr. Wisseman's Laboratory

It was assumed that complement-fixation titers of at least 1:8, and/or microagglutination titers of at least 1:8, indicate the presence of specific antibodies to epidemic typhus rickettsiae. Individuals who had complement-fixation titers of less than 1:8, and/or microagglutination titers of not over 1:4, were considered, for the purpose of this study, as seronegatives.

Complement-Fixation - It should be pointed out that in both the Ness-Ziona laboratory and Dr. Wisseman's laboratory, a high proportion of sera showed anticomplementary activity. In Dr. Wisseman's laboratory, 551 out of 1661 specimens (33.2%) were anticomplementary.

Of the total number (293) of volunteers tested, 19 were excluded since all their sera exhibited anticomplementary activity in the CF test. The 274 remaining cases were divided into three groups (Table 1) as follows:

Group A (CF negative) - includes 90 individuals (32.8%).

Group B (CF positive) - includes 140 persons (51.1%) whose sera showed a CF titer of 1:8, or higher in at least one of the bleedings, but did not show significant fluctuations in titer.

Group C (at least four-fold fluctuations in titer) - includes 44 individuals (16.1%). Variation in titer occurred in successive or in non-successive bleedings. Some of them showed an eight-fold rise or fall in titer; others presented four-fold fluctuations. Results pertaining to this group are presented in Table 2.

Microagglutination - The sera of 293 volunteers were examined by this method. Here again they were divided into three groups (Table 3).

Group A (MA negative) - includes 38 volunteers (13%) whose sera constantly showed a titer of <8.

Group B (MA positive) - includes 217 individuals (74%) in whom at least one serum showed an MA titer of ≥ 8 , but did not show significant fluctuations in titer.

Group C - includes 38 persons (13%) whose sera demonstrated at least four-fold fluctuations in MA titer. Details pertaining to Group C are presented in Table 4. It may be seen that the majority of cases (26) showed four-fold fluctuations; 3 persons exhibited eight-fold changes; 4 cases showed sixteen-fold changes; 4 individuals presented thirty-two fold changes and 1 person showed sixty-four fold fluctuations in titer.

Summary of Serological Findings

As stated above the sera of only 274 volunteers were successfully examined by both serological methods. When comparing the results of the two methods, it can be seen that 165 cases (60.2%) out of 274, they were similar (Table 5). Thirty volunteers (10.9%) were found to be seronegative by both tests and belong to Group A; 124 individuals (45.3%) fall into Group B, and 11 volunteers (4%), who exhibited at least four-fold fluctuations in titer by the two serological methods, fall into Group C.

2. Comparison of Results Obtained in the Collaborative Laboratories

It is well known that it is difficult to correlate the results of CF tests carried out in various laboratories. This was also true in this case when the findings of the two laboratories were compared. From Table 6 which shows the comparison of the CF test results obtained it can be seen that correlation was found in 166 out of 251 cases whose sera were examined by the same test in the laboratories, representing 66.1% of the total number. Out of 166 cases 50 (19.9%) were found to be seronegative (Group A); 108 (43%) belong to Group B, and only 8 persons (3.2%) showed at least four-fold fluctuations (Group C).

When comparing the findings of the MA tests it can be seen that, in this test too, there were discrepancies between the collaborative laboratories (Table 7). The sera of 284 persons were examined by this method and correlation was found in 217 (76.4%). Among them 28 (9.9%) belong to Group A; 181 (63.7%) to Group B, and 8 (2.8%) to Group C (at least four-fold fluctuations).

From the facts presented it can be concluded:

1. When comparison is made between the results of the two laboratories, the correlation for the CF was found in 66.1%, and for the MA in 76.4%.
2. For Group C which is of special interest as it includes volunteers whose sera exhibited at least four-fold fluctuations in antibody titers, the correlation by CF was found in 3.2% and by MA in 2.8%.

Remarks

It should be emphasized that the considerable differences found in the results of the complement-fixation (CF) tests between the two laboratories, might be due to the fact that different sequences of dilutions were used by each laboratory. (In Dr. Wisserman's laboratory the starting point was 1:2, whereas in the Ness-Ziona laboratory 1:10). There is not necessarily a one-to-one transformation between the

two titer estimates that are obtained with different sequences of dilutions*. Namely, for an estimate obtained with one sequence, there are two estimates that are expected to be obtained with another sequence. For example, a specimen in which the expected titer is estimated as 1:16 with the sequence 1:8; 1:16; 1:32;... is expected to be estimated as 1:10 or 1:20, when the sequence 1:10; 1:20; 1:40;... is used. Therefore the comparability of estimates obtained with two such sequences is questionable.

Moreover, it can be shown* that with sequences 1:8; 1:16; 1:32;... a larger proportion of individuals with "serorelapses" can be identified as compared to a study in which the sequence 1:10; 1:20; 1:40;... is used.

In fact the starting point of the sequence used in Dr. Wissemann's laboratory was 1:2 and not 1:8. This might increase even more the proportion of those identified as individuals with serorelapses. An individual with a minimum (among the specimens taken from him) titer value that is smaller than 8, will be considered as belonging to Group C (serorelapse) with a sequence starting at the dilution 1:8, if his titer estimates attained at some time a value of 32 or more; whereas with a sequence of 1:2; 1:4; 1:8;... his minimum titer value might be estimated as 1:2 or 1:4 and with a maximum titer value as low as 8 or 16 respectively he will be identified as having serorelapses.

In addition, for some obscure reasons, a higher level of anticomplementarity was encountered in our laboratory. Under these conditions a lower proportion of individuals with "serorelapses" could be expected to be identified in our laboratory. The reasons evolves from the fact that anticomplementarity raises the titer values; so that a certain individual with a specific antibody titer that fluctuates within a four-fold range might not be identified as having serorelapses because of the presence of anticomplementary substances that do not fluctuate accordingly.

* Rina Chen - Comparability of Titers Estimated with Dilution Sequences with Different Starting Points, in:
"The Nature of Biostatistics:Contributed Papers by Department of Biostatistics Alumni in Honor of Dr. Antonio Ciocco to Commemorate Twenty Years as Head of the Department", University of Pittsburgh, Pittsburgh, Pennsylvania, 1969.

Table 1*

Grouping of Volunteers According to the Results of Serial CF Tests †

Individuals under study	Total	Group A (CF negative)	Group B (CF positive)	Group C (at least four-fold fluctuations in CF titer)
Number	274	90	140	44
Percent	100	32.8	51.1	16.1

* Results obtained at the Department of Microbiology, University of Maryland School of Medicine, Baltimore, Maryland.

† The table does not include persons of whom all sera exhibited anticomplementary activity.

Table 2*

Complement-fixation (CF) Tests of Sera of Forty-four Individuals
Showing Fluctuations In Epidemic Typhus Antibody Titer (Group C)

Case Number	CF titer of serial bleedings					
	I	II	III	IV	V	VI
11	32/8	8/4	8/4	8/8	4	4
21	16/4	16/4	8/2	8/4	32/4	64
27	2	<2	<2	2	16	
28	16/4	16/4	8/4	16	4	4
36	16/8	16/4	4/2	2	<2	<2
39	16	16	32/2	16	16	<2
40	32/4	16/8	8/2	4	4	4
42	16/4	4/2	4/2	8	<2	<2
44	<2	32	<2	16/4	<2	<2
47	32/2	16	32/8	32/8	8	16
59	16/4	16/8	16/8	16/8	4	4
70	32/8	16/8	16/4	16/4	4	4
74	64/16	8/8	8/2	4/2	16/2	4/2
77	8/4	32/8	64/16	8		
82	32/16	16	8	32/2	8	8
202	8/4	16/4	16/2	32/4	8	<2
213	64/2	32/8	32/8	32/8	16/4	16
218	8		16	16/4	16/8	<2
225	32/8	32/4	32/2	32/4	16	8
236	256/4	64/2	32	32/4	16	16
245		4/2	2	4	8	4/4
301	16/4	16/4	16/8	32/8	64/8	8/2
305	8/2	8/2	8/2	2/2	8/2	8/2
306	4/2	4/2	4/4	16/2	<2	<2
311	16/2	16/2	16/2	8/2	8/2	2
401	8/4	8/4	8/2	64	16	4
403	32/4	8/2	16/4	4	4	<2
405	32/16	32/4	32	4/4	16/2	16
408	64/8	16/8	16/8	16/8	8	2
419	64/8	64/16	16	32/8	32/2	8
421	16/8	16/4	4	8	4	<2
449	2/2	2/2	<2	<2	8	2
463	16/4	16/4	4/4	16/2	16	16
474	16/2		16/4	8/2	2	8/8
486	8/2	8/2	8	4	4	2
509	8/2	4	4	8	8/2	2
517	16	16	8		4	4/8
518	8/2	8	8/2	8	<2	4
606	16/2	8/4	8/2	4		<2
810	32/8	16/8	8/4	8/4	4/2	4/4
820	16/8	8/8	<2	16/8	8/2	16/4
845	8	16/8	16/8	16/4	16/8	2
858	32	32/2	32/2	32	32	4
859	8/4	8/2	8/2	4	32	4

* Results obtained at the Department of Microbiology, University of Maryland School of Medicine, Baltimore, Maryland.

Table 3*

Grouping of Volunteers According to the Results of Serial MA Tests

Individuals under study	Total	Group A (MA negative)	Group B (MA positive)	Group C (at least four-fold fluctuations in MA titer)
Number	293	38	217	38
Percent	100	13.0	74.0	13.0

* Results obtained at the Department of Microbiology, University of Maryland School of Medicine, Baltimore, Maryland.

Table 4*

Microagglutination (MA) Tests on Sera of Thirty-eight Individuals
Showing Fluctuations in Epidemic Typhus Antibody Titer (Group C)

Case Number	MA titer of serial bleedings					
	I	II	III	IV	V	VI
23	32	16	16	16	8	16
27	8	8	8	8	64	
42	≤2	≤2	≤2	16	≤2	≤2
47	64	128	128	64	64	32
57	128	128	128	256	128	64
58	128	128	64	128	64	32
66	64	128	64	32	32	32
69	4	4	8	8	8	16
79	16	16	32	16	64	64
84	64	128	64	32	64	64
92	128	64	128	32	64	128
95	64	32	64	32	16	32
99	32	16	16	16	≤2	16
201	8	8	8	2		
203	32	64	32	32	16	32
209	≤2	16	16	8	16	16
220	4	4	4	8	8	16
230	64	64	64	16	16	64
236	512	128	128	64	64	64
240	32	64	16	32	32	32
246	≤2	≤2	≤2	≤2	32	≤2
263	64	64	64	32	32	128
306	64	64	64	32	64	128
405	64	64	32	32	32	128
440	16	4	4	4	4	4
453	128	64	32	64	64	64
459	2	2	64			
463	128	128	4	128	64	64
474	64	16	16	16	32	32
503	64	64	≤2			
507	16	16	16	16	4	16
705	≤2	8	8	8	8	8
811	64	64	32	64	128	64
819	16	16	16	16	≤2	16
820	≤2	≤2		≤2	16	≤2
840	128	128	64	32	64	64
858	128	128	128	128	128	32
859	32	32	32	32	128/64	32/16

* Results obtained at the Department of Microbiology, University of Maryland School of Medicine, Baltimore, Maryland.

Table 5†

Comparison of Results Obtained by Complement-fixation and Microagglutination Tests for Epidemic Typhus Antibodies

Microagglutination Complement fixation	Group A*	Group B**	Group C***	Total
Group A*	30	53	7	90
Group B**	-	124	16	140
Group C***	3	30	11	44
Total	33	207	34	274

† Results obtained in the Department of Microbiology, University of Maryland
School of Medicine, Baltimore, Maryland.

* Seronegative

** Seropositive

*** Seropositive showing fluctuations in titer of at least four-fold.

Table 6
Comparison of Results Obtained by Complement-fixation Test for Epidemic Typhus
Antibodies as Found in the Collaborating Laboratories

Lab. N†	Group A*	Group B**	Group C***	Total
Lab. B††				
Group A*	50	23	4	77
Group B**	7	108	17	132
Group C***	13	21	8	42
Total	70	152	29	251

† Lab. N - Israel Institute for Biological Research, Ness-Ziona.

†† Lab. B - Department of Microbiology, University of Maryland School of Medicine,
Baltimore, Maryland.

* Seronegative

** Seropositive

*** Seropositive showing fluctuations of at least four-fold.

Table 7

Comparison of Results Obtained by Microagglutination Test for Epidemic Typhus
Antibodies as Found in the Collaborating Laboratories

Lab. N†	Group A*	Group B**	Group C***	Total
Lab. B††				
Group A*	28	5	4	37
Group B**	9	181	26	216
Group C***	2	21	8	31
Total	39	207	38	284

† Lab. N - Israel Institute for Biological Research, Ness-Ziona.

†† Lab. B - Department of Microbiology, University of Maryland School of Medicine,
Baltimore, Maryland.

* Seronegative

** Seropositive

*** Seropositive showing fluctuations of at least four-fold.

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13. ABSTRACT

The study was undertaken in order to determine whether persons, once infected with epidemic typhus, could subsequently suffer relapses, without clinical signs which could presumably serve as sources of the microorganism in the inter-epidemic period and therefore be responsible for the initiation of new epidemics. The study was conducted among individuals most of whom had contracted typhus in Eastern Europe and immigrated after the Second World War. In enlisting volunteers for the study, particular attention was paid to the reliability of their histories and to the absence of murine typhus in their present environment. 294 individuals were thus selected. Interviews and sampling of bloods were conducted at regular 2-3 months' intervals. Six blood samples were obtained from 262 individuals and at least three samples from the rest. The presence of antibodies specific for epidemic typhus in these samples was tested by complement-fixation and microagglutination. It was found that 12% of the volunteers had no demonstrable antibodies, while 67% considered to have such antibodies but showed no significant titer fluctuations. Finally, 21% of the volunteers exhibited four to eight-fold fluctuations in titer in at least one of the tests used, thus suggesting the possibility of serological relapse.

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